# THE WHY DIMENSION – OPENING FRONTIERS FOR DIGITAL LEARNING

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## Keywords

e-learning, digital learning, ICT, sense-making, semantics, metadata, inquiry, inquiry-based learning, dialogic inquiry, reflective inquiry, reflective practice, integrated reflection, scaffolding, why, why-questions, why dimension, primitive questions, cognitive engagement, question generation, question-answering, knowledge creation, knowledge modelling.

## Abstract

Among the narratives associated with the evolution of e-learning are themes such as the transformation of education by global informational infrastructures, emergence of a 'knowledge age' through innovation in knowledge sharing technologies and 'open' protocols, empowerment of the individual in terms of the place and time of learning, democratisation of media and content production through the rise of social media, and the development of technologies conducive to inquiry-based learning. This thesis is primarily concerned with the latter narrative in which developing support for inquiry through digital technology is of central concern. A transdisciplinary approach is adopted in which *sense-making* and *knowledge modelling* provide pivotal perspective on one word that is both versatile and ambiguous: '*why'*. Given that *why-questioning* often occurs while learning and making sense of things a key question addressed in this thesis is why current digital technologies do not explicitly support basic act. Specifically, this thesis introduces the *why dimension – asking, learning, understanding, knowing,* and *explaining why* – as an emergent construct of interrelated activities that can inform development of software technologies opening up a frontier of possibilities for inquiry-based digital learning: it explores, interrogates, and aims to scrutinise the opportunities and challenges arising. Within this construct reflection and dialogue are represented as polar facets of inquiry activated by reasoning and scaffolded by technology. Technical challenges associated with the representation and retrieval of digital content are identified and the *search paradigm* is introduced as a construct that explains a dominant but shallow form of inquiry enabled by mainstream contemporary Internet tools and shown to privilege the retrieval and discovery of

*informational* as opposed to *explanatory* content. Informational content is shown to be retrievable by queries reducible to a set of *primitive questions*: *who what, when,* and *where*. Explanatory content is identified as a typical, expected response to *why*-questioning. Issues concerning cognitive engagement and deep inquiry are found to be associated with reflective and dialogic inquiry. In a similar way that the *why dimension* is presented as a conceptual tool that can inform the design and development of digital technology that supports learning, *sense-making technologies* are distinguished from semantic technologies and identified as likely to occupy a new frontier of development.

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# List of Abbreviations

| | |
|---|---|
| ADL | Advanced Distributed Learning |
| ALTC | Australian Learning and Teaching Council |
| CSCL | Computer Supported Collaborative Learning |
| DC | Dublin Core |
| DCMI | Dublin Core Metadata Initiative |
| DIKW | Data Information Knowledge Wisdom |
| EML | Educational Modelling Language |
| ICT | Information and Communications Technology |
| IEC | International Electrotechnical Commission |
| IEEE | Institute of Electrical and Electronics Engineers |
| IMS | Instructional Management Systems |
| | (now IMS Global Learning Consortium) |
| ISO | International Organization for Standardization |
| IT | Information Technology |
| ITLET | Information Technology for Learning, Education, and Training |
| JISC | Joint Information Systems Committee |
| JTC1 | Joint Technical Committee 1 |
| KM | Knowledge Management |
| LOM | Learning Object Metadata |
| LTSC | Learning Technology Standards Committee |
| OER | Open Educational Resources |
| OKI | Open Knowledge Initiative |
| OWL | Web Ontology Language |
| QG | Question Generation |
| Q-A | Question Answering |
| SC36 | Sub-Committee 36 (IT for Learning, Education, and Training) |
| TEL | Technology Enabled Learning |
| RDF | Resource Description Framework |
| XML | eXtensible Markup Language. |

## Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.



Signature:

Date: 30 – March – 2014

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# Chapter 1: Introduction

This thesis establishes a theoretical base from which future development of inquiry-based digital learning can be informed. It places a powerful yet semantically ambiguous word '*why'* as the centerpiece of a transdisciplinary investigation that probes and srutinises the challenges and opportunities associated with designing digital technologies that aim to support the *why dimension – asking, learning, understanding, knowing,* and *explaining why*.

This work builds upon research findings across a number of disciplines and discourse communities that collectively represent a broad conceptual area of study: information science, educational psychology, philosophy of education, computational linguistics, educational technology, digital learning, intelligent tutoring, and knowledge management. It is necessarily broad in conception because the challenges associated with supporting the *why dimension* with digital technology are shown to be varied and complex. As such, this work is *trans*disciplinary while also aiming to be *inter*disciplinary: while both approaches extend beyond disciplinary categories *transdisciplinary* refers to reaching across and drawing from multiple disciplines, while *interdisciplinary* refers to the integration of categories from distinct disciplines to produce new constructs (Repko, 2012, p. 4). This work is also informed by practice and trends in the standardization and deployment of information and communications technology (ICT) systems and services that facilitate e-learning. It is further informed by various methodologies developed to assist in "sense-making".

Central to this endeavour is a narrative associated with the *evolution of e-learning* and the role that *knowledge modelling* has in informing the design of the

ICT components that either singly or together might enable a learning experience or event. Importantly, as this study proceeded, the issue of terminology had to be addressed and revisited in one key area: it is argued that while the term *e-learning* has become embedded in both theory and practice it is a term that evidence shows is giving way to the more inclusive term, *digital learning* – learning that is enabled by a diversity of digital technologies whether online or not. This is reflected in the portfolio of published papers that forms a substantive part of this body of work. However, for continuity and coherence reasons the term *e-learning* has also been retained within this thesis and used interchangeably.

This chapter first outlines the background, evolving context, motivation and rationale for this investigation – including some technical perspective for illustrative purposes – followed by discussion of its significance and scope. The issue of terminology is dealt with at length and a summary of the core constructs used throughout is provided with associated terminology and definitions (*Table 1.2 and Figure 1.3*). Finally, an overview of the remaining structure of the thesis is presented.

**Background**

The background drivers to this research date back to 1998 with the engagement of the researcher in international ICT standards development activities associated with the evolution of the World Wide Web and its adoption within the global education and training sector as a transformational platform. These activities were focused on various iterations of modelling the technical components that would best support the development of a sustainable and interoperable e-learning infrastructure and collaboratively developing technical specifications from these models to

facilitate this. Such activity was ambitiously summarised by the Instructional Management Systems (IMS) Project in 1999 as "Defining the Internet Architecture for Learning" (IMS, 1999; Mason, 2000).

These standardization activities were situated across five international organizations: IMS (known as the IMS Global Learning Consortium since 2001), an industry-based membership consortium; the Dublin Core Metadata Initiative (DCMI), an emergent organization comprised of digital library and metadata individual experts; the Advanced Distributed Learning (ADL) Initiative, a US-Government funded project initially focused on supporting military and paramilitary training; the Institute of Electrical and Electronics Engineers (IEEE) Learning Technology Standards Committee (LTSC), a professional association of IT experts; and, Sub-Committee 36 (Information Technology for Learning, Education, and Training) of Joint Committee 1 (JTC1) of the International Organization for Standardization (ISO) and the International Electrontechnical Commission (IEC), a formally constituted body that involves representatives of national standards bodies (such as Standards Australia) and known by the abbreviation SC36.

Much of the early focus for these standards organisations during 1998-2004 was concerned with developing metadata schemas and specifications for describing and packaging content (such as "learning objects" or "sharable content objects") that would facilitate content modularity and management, targeted information retrieval, resource discovery, and interoperability of learning management systems (Institute of Electrical and Electronics Engineers, 2002; Advanced Distributed Learning, 2004). The legacy of this work can be seen today in contexts where learning management systems still play a dominant role in the online learning experience for academic teaching staff and students in universities and vocational colleges. While not all

standardization efforts delivered useful outcomes over this period the most successful, in terms of adoption, were Dublin Core (DC) metadata, the IEEE Learning Object Metadata (LOM), and the Sharable Content Object Reference Model (SCORM) (International Organization for Standardization, 2003; Institute of Electrical and Electronics Engineers, 2002; Advanced Distributed Learning, 2004). Each of these standards (or the metadata schema contained within them, in the case of SCORM) was concerned with defining the attributes of either generic content or specially purposed learning content – these attributes were expressed as structured sets of formally constrained semantics and supported by controlled vocabularies that were essentially *descriptive* in nature – in other words, they were concerned with the *aboutness* of content. For example, content can be described in terms of the subject area it is concerned with, who created it, where it can be accessed or located, its file format, when it was published, or the educational level that might be associated with it. Critical to this thesis is that such descriptions can also be seen as facets or expressions of semantics reducible to *who, what, when,* or *where* information. Describing content this way is necessary because computer systems cannot easily interoperate without precise, formally defined semantics and syntax and, therefore, such an approach serves as a foundation for a diversity of metadata schemas – ranging from those that aim to provide general cross-domain utility (as in the case of the 15 Dublin Core metadata elements) to schemas that are highly specific (as in the case of the 84 elements of the IEEE LOM).

This logic of this approach, however, also brings with it an important constraint: it privileges a conception of content framed in terms of *nouns*, thereby leaving aside many questions as to the activities (*verbs*) associated with learning – such as inquiring, reasoning, discussing, problem solving, and reflecting, as well as

the variability of the context in which content might be accessed or interacted with. Questions associated with defining the difference between *content* and *learning content* soon arose within the standards organisations (Olivier & Liber, 2003; Verbert & Duval, 2004); vendors began to market *learning content management systems* and *course management systems* as distinct from *content management systems* (Simon et al., 2003; McGee et al., 2005); IMS began developing a specification called *learning design* that moved the focus from *content* to *learning activities* (IMS, 2003a); Educational Modelling Language (EML) was being developed as another computational approach to support e-learning based upon eXtensible Markup Language (XML) syntax and with a core focus on modelling "units of learning" that embraced both content and activities (Koper & Manderveld, 2004); while others began to explore the prospects of using ontologies to provide the glue to create coherent frameworks that could represent the domain of "content, context, and pedagogy" (Knight et al., 2005). Thus, the project originally articulated by IMS as "defining the Internet architecture for learning" was beginning to take on a character of abstract complexity (IMS, 1999; IMS 2003b) that attracted the collaboration for some years with the Open Knowledge Initiative (OKI) hosted by the Massachusetts Institute of Technology (Thorne, 2002). Emerging from this context was a question as to whether the modelling activities in relation to knowledge and metadata were sufficient, accurate, or complete. The modelling that defined digital learning content as nouns (such as resources, learning objects, data, information, and knowledge) and learning activities (as verbs) begged the question as to whether conceiving of learning content in such terms needed to be reconsidered.

Early attempts of the researcher to model this "problem space" were proposed in various publications at the time (Mason & Lefrere, 2003, p.264; Mason, 2004) – an example is shown in *Figure 1.1*.

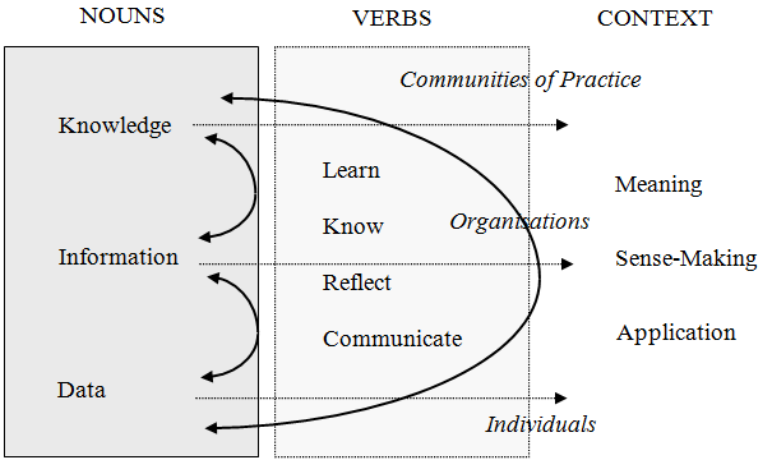


*Figure 1.1*. Early modelling of the problem space. (Mason & Lefrere, 2003)

*Figure 1.1* is included here to highlight some conceptual origins that attempt to represent relationships among key terms also used in this thesis, namely: *data, information,* and *knowledge*; *learn, know, reflect,* and *communicate*; *meaning* and *sense-making*. This graphic was also intended to depict movement and dynamic relationships between conceptual entities. Absent from this conception were the terms *teach* and *pedagogy*; however, including them would have added further complexity and distorted its purpose, which was to serve as a stimulus for making sense of the dynamics of *content* components in relation to meaning-making and sense-making through activities such as learning, knowing, and communicating.

At this time there also existed numerous narratives about *convergence* brokered by digital technology. The narrative on the convergence of work and learning was already well advanced and often expressed in terms of *lifelong learning* (Tight, 1998; Heywood et al., 1999; Radcliffe, 2002; Collinson et al., 2003) but now

also commonly referred to as *work-integrated learning* or WIL (Cooper, et al., 2010). There was a dominant economic and market narrative concerning the convergence of IT systems, telecommunications, broadcast media, and consumer electronics (Yoffie, 1997; Lind, 2004). Of significance for the genesis of ideas that have motivated this thesis was also the convergence of digital infrastructure that included digital library systems, learning technology systems, and knowledge technology systems (Woelk, 2002; Thorne, et al., 2002; Norris, et al., 2003; Bowles, 2004; Blinco, et al., 2004; Lytras et al., 2005). For the researcher, this particular convergence of digital technology systems prompted investigation of knowledge and content modelling common within the discourse on knowledge management (Nonaka & Takeuchi, 1995; Snowden, 2002). This investigation led to development of a faceted model of knowledge that exposed *knowing-why* as a construct (Mason & Lefrere, 2003, p. 268) that may have relevance to the design of e-learning systems. Its problematic aspects – such as those associated with semantic ambiguity – were not understood until embarking upon the research for this thesis some years later. Nonetheless, this early work is where the origins of some of the ideas for this thesis emerged.

It is important to highlight here that while these narratives on convergence made sense they also masked the reality of a significant counterpoint: fragmentation. Because the ICT infrastructure of the Web was evolving so quickly one of the challenges in achieving technical interoperability across domains was that different communities of practice (for example, communities engaged in developing infrastructure to support digital libraries, digital publishing, knowledge management, e-learning, the semantic web, and multimedia for entertainment) were all producing technical specifications to enable modular or interoperable content. Unfortunately,

mapping between these specifications presented many challenges making interoperability difficult to achieve. The following two case-studies underscore this.

The first case was the '*IEEE Standard for Learning Technology—Conceptual Model for Resource Aggregation for Learning, Education, and Training: 1484.13.1-2012,* a standard focused on harmonising industry-accepted but incongruent content aggregation models (Institute of Electrical and Electronics Engineers, 2012). Work for this standard commenced in March 2003 with the aim of developing a technical ontology that could map between the various content aggregation standards and thereby enable a pathway to interoperability and content exchange. Due to the complexity involved it was not finalised as a standard until March 2012, representing a decade of international collaboration to achieve this goal.

The second case was the technical work that produced a 'binding' (a technical specification expressed in a computational language) of the IEEE LOM in Resource Description Framework (RDF) required consensus building involving experts from both the Dublin Core and IEEE communities. Essentially, it demanded harmonisation of the syntax and structural rules of XML (a mark-up language) with the *entity-relationship model* that is at the core of RDF, a knowledge representation language that underlies the Semantic Web project of the World Wide Web Consortium. This work required abstract modelling over a number of years to achieve the harmonisation needed and demonstrates that rendering the semantics and syntax of diverse metadata schemas focused just on *describing* content can be a technically sophisticated exercise requiring the development of adequate abstract models (Nilsson, 2010).

Both standards represent important contributions to standards development aimed at achieving interoperability, though both were only achieved through numerous iterations of candidate abstract models within a tightly defined scope of work. Despite both standards addressing issues with learning content, neither of them touched upon semantics associated with the *why dimension*. This then has been another source of motivation behind this thesis.

**Evolving Context of e-Learning**

The influence of the technical standards agenda outlined above should be seen as just one narrative among many concerning the evolving digital infrastructure supporting e-learning; a narrative that has placed *technical interoperability* at the forefront of its strategic agenda.

Another prominent narrative to emerge from this period was that associated with the Web 2.0 revolution and engagement with social media in educational contexts. In this narrative, emphasis was (and still is) placed upon networks in any representation of the components of digital learning and how learning is being transformed. "Connectivism" was proposed as a new theory of learning relevant for the "Digital Age" in which technology networks are conceived as enabling new and rich connections to a diversity of entities all linked to continual learning and activities in which "the pipe is more important than the content within the pipe" (Siemens, 2004).

As the discourse on connectivism developed much of what was said about the increasingly networked world we live in seemed compelling – except for one major concern: as a theory of learning it seemed to be ironically reductionist in its preoccupation with assigning networks such a preeminent role in how learning takes

place. That it has a significant role is not of contention here; but in terms of completeness such a proposition is deficient in dealing with the nature of reflective and dialogic inquiry, although in recent connectivist literature this has been given some attention in terms of "dialogue-rich networked learning" (Ravenscroft, 2011).

Elements of the connectivist discourse, however, were also beginning to find similar expression within the knowledge management (KM) literature as it evolved and endeavoured to come to terms with the socio-technical dimension of ICT-enabled "knowledge networks" (Back, et al., 2006; Seufert, et al., 2003).

> Concerning the integration of networking and knowledge management, we believe two aspects to be crucial. First, knowledge management should comprise a holistic view of knowledge, meaning the integration of explicit and tacit knowledge. Furthermore, knowledge management should take a holistic view on where and how knowledge is being created and transferred […] The integration of networking into knowledge management yields great benefits. The openness and richness of networks […] foster a fertile environment for the creation of entirely new knowledge.
>
> (Seufert, et al., 2003, p. 105-106)

There appeared to be much from this discourse – such as knowledge creation models (Wierzbicki et al., 2006) and representations of "process knowledge" linked with information and data in a "value chain" (Holsapple & Singh, 2001) – that either mapped to or intersected with the discourse on e-learning (Marshall, et al., 2003; Schmidt, 2005). Moreover, the ICT systems that were being implemented for KM and e-learning purposes shared much in common and new international journals began to emerge that focused specifically on *learning* and *knowledge* within a digital technology context (Lytras & Sicilia, 2005; Wang & Yang, 2009).

This then summarises both the background drivers and context that have informed the trajectory for this investigation.

**Purpose**

While the convergences of ICT systems emerged as a topic in itself worthy of deeper analysis it was a specific aspect of such developments that came into focus as the research question and direction for this thesis:

(1) *Why is it that in the evolution of digital technology there has been little explicit innovation for supporting 'knowing why' in knowledge management and 'asking why' in e-learning*?

This question was formed prior to the formulation of the emergent construct, the *why dimension*. Following this development the research focus is re-phrased as:

(1) *Why is it that in the evolution of digital technology there has been little explicit innovation for supporting the why dimension*?

A second question closely aligned to this focus also emerged as it became clear that linguistics and cognitive psychology could also inform this work:

(2) *In what ways can modelling knowledge inform how 'why-questioning' might be supported during e-learning?*

The notion of *primitive questions* guided initial research, and is highlighted in the first paper (Chapter 3). Over time, an emergent construct began to form as the *why dimension – asking, learning, understanding, knowing,* and *explaining why*. In terms of the second research question outlined above the conceptualisation of *why-questioning* was superseded by this construct during the course of this investigation. Thus, the overarching purpose of this study consolidated as a theoretical

investigation into the existing and potential role of digital technology support for the *why dimension* in e-learning.

Following on from the two research questions identified above are a number of sub-questions that have also motivated and guided the research. These sub-questions are listed in *Table1.1* and mapped against the papers they are addressed in. They are further elaborated upon in each relevant chapter. In the similar way as *consequent questions* function or arise from *why*-questioning, these sub-questions are a natural consequence of an inquiry-based approach to both the topic and the two central research questions. They also suggest an underlying complexity to the issues that are dealt with in each of the papers.

Table 1.1

*Sub-Questions*

| | Sub-Question | Papers | Comment |
|---|---|---|---|
| i. | Why does the *why dimension* present challenges to ICT development? | 1, 2, 4, 6 | Understanding the technical reasons for this situation assists in identifying the scope of the challenge. |
| ii. | How might the *why dimension* establish theoretical bases for conceiving of e-learning and knowledge management as convergent? | 1, 4, 7 | Theory and practice associated with any discourse are mutually informing. Within the papers presented here, theoretical analysis represents reflection upon and synthesis of existing theories and practice as well as a probing into plausible futures that accommodate technology support for the *why dimension*. |
| iii. | If *who, what, when,* and *where* represent the reducible semantics of metadata schemas what other 'core' questions are there relevant to learning or knowledge? | 1, 4, 5, 6 | This set of four terms can be used for a variety of linguistic functions: as standalone questions they focus on information-seeking; as facets or objects of knowledge (as in 'know-who' etc.) they help organise information. Given this prominent role where does *why* fit? |
| iv. | If digital content is typically described by semantics that extend *who, what, when,* and *where* information, and such descriptions provide a pathway into the discovery and interaction with content, what other pathways for discovery and | 2, 3, 4, 6, 7 | A key contribution of this thesis is identifying the difference between content that can be easily described and content that might be *explanatory* in nature. *Asking why* in e-learning is an act of inquiry that seeks an |

| | | | |
|---|---|---|---|
| | interaction might be possible? | | explanation rather than a description. |
| v. | How might learning content that is relevant to *why*-questioning be managed, discovered and shared? | 4, 5, 6 | The principal role of metadata is to describe and identify content; however, it is proposed that it could also usefully perform an *explanatory* role as well as identify *explanatory* content. |
| vi. | What are the prominent narratives associated with the evolution of e-learning? | 2, 3, 6 | Developing a background narrative on the evolution of e-learning is identified as important for positioning the *why dimension* as opening frontiers for development. |
| vii. | How is inquiry understood within learning theory? | 3, 5, 6, 7 | Inquiry proceeds in various ways but underpinning it is the framing of questions; questioning online is distinguished clearly from what is characterised as the *search paradigm.* Inquiry-based learning is highlighted as offering a sound theoretical base for exploring opportunities for supporting the *why dimension.* |
| viii. | How is scaffolding conceived of and implemented within e-learning contexts? | 6 | The meaning of this term is shown to have evolved since its first usage within learning theory and dramatically since the development of the World Wide Web. Mainstream search engines scaffold searching but privilege *what, where, when,* and *who* information. |
| ix. | What epistemological perspectives are relevant in the consideration of the *why dimension*? | 7 | Epistemology serves an important theoretical role in the framing of social and educational research. For this thesis, it is particularly important because of its concern with the theory of knowledge. |
| x. | Because *why*-questioning typically requires reflective or dialogic engagement what might be learned from investigating issues of cognitive engagement while learning with digital technology? | 2, 5, 6 | *Cognitive engagement* is introduced as a construct that involves a rich mix of cognitive activities and literature is explored largely from the perspective of reflective practice. |
| xi. | How can the *why dimension* be represented through abstract models? | 1, 4, 6, 7 | Existing well-known models associated with knowledge and learning are presented alongside proposed frameworks and constructs for sense-making. |
| xii. | How is and how might the *why dimension* be supported by digital technology? | 5, 6, 7 | Existing systems such as e-portfolios, wikis, and intelligent tutoring systems are discussed. Deep questioning, through questions propagating questions is proposed |
| xiii. | Is there a functional difference between *meaning-making* (interpreting semantics, patterns, and rules) and *sense-making* (where reasoning, reflection, and dialogue | Chapter 10 | Investigation into sense-making models reveals a communication function that requires reasoning as well as interpretation and |

| | |
|---|---|
| are prominent)? | understanding. |

The two primary research questions, together with the sub-questions in *Table 1.1,* are addressed in the papers included in this thesis. These questions are addressed in a variety of ways: through presentation of evidence in the form of research findings from the relevant literature; through proposing plausible explanations; and, through the emergence of *consequent questions* that invite further inquiry. Chapter 10 provides further summation, focusing on the theoretical contributions of this thesis to the discourse on e-learning.

**Scope**

At the core of this investigation is one word: *why*. It is a word that has communicative versatility in most natural languages; however, such versatility brings with it ambiguity in terms of semantic function and this presents a significant challenge for parsing within computer systems. Not only is this word commonly found in questions but also within a range of other linguistic expressions. From a grammatical perspective it can function as an interrogative (simply as *why?*), as an adverb (as in *why do we sleep?*), as a relative pronoun (as in *there is no reason why she shouldn't attend*), as a noun (as in *he provided an analysis of the question why*), and as an interjection (as in *why, you've got to be joking!*). These just represent a small sample as the linguistic versatility enables nuance of expression. However, linguistic perspectives represent just part of the picture and because *why* is a central construct of this investigation it has necessitated a transdisciplinary approach. Thus, relevant literature concerning this topic has been drawn from disciplines and domains of practice spanning (but not limited to) linguistics, information science, educational psychology, philosophy of education, computational linguistics,

educational technology, digital learning, intelligent tutoring, and knowledge management.

Two concept maps were developed to organise some of the core constructs that would be used as points of focus for research papers included in this thesis. These are represented as *Figure 1.2* and *Figure 1.3* and constitute instances of one approach to knowledge modelling (using concepts, propositions and relationships). *Figure 1.2* depicts the individual learner at the centre of interactions involving ICT, content, and learning supports (which can include teaching, interaction with peers and mentors, and optional scaffolding). Such a model aligns with an inquiry-based approach to learning (Oliver, 2008) in which the learner is depicted at the centre of processes, a depiction that emphasises the potential for self-directedness.

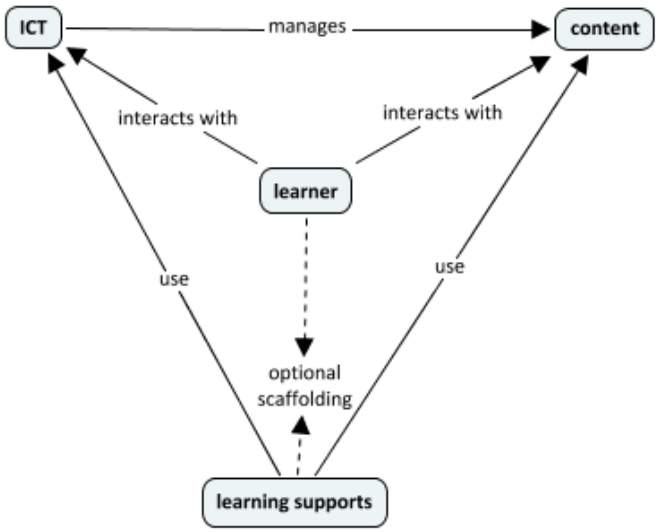


*Figure 1.2.* Core entities and relations in digital learning

*Figure 1.3* represents a summary of the conceptual complexity associated with '*why'* in which clear distinction is made between *information* and *explanation* where the associated semantics respectively factual or contextual. Distinction is also made

between *reflective* and *dialogic* pathways to inquiry, sense-making and learning – while both are strongly linked to cognitive engagement.

*Figure 1.3* also provides an enduring representation that guided the selection of relevant domains of inquiry that are shown in *Figure 1.4*.

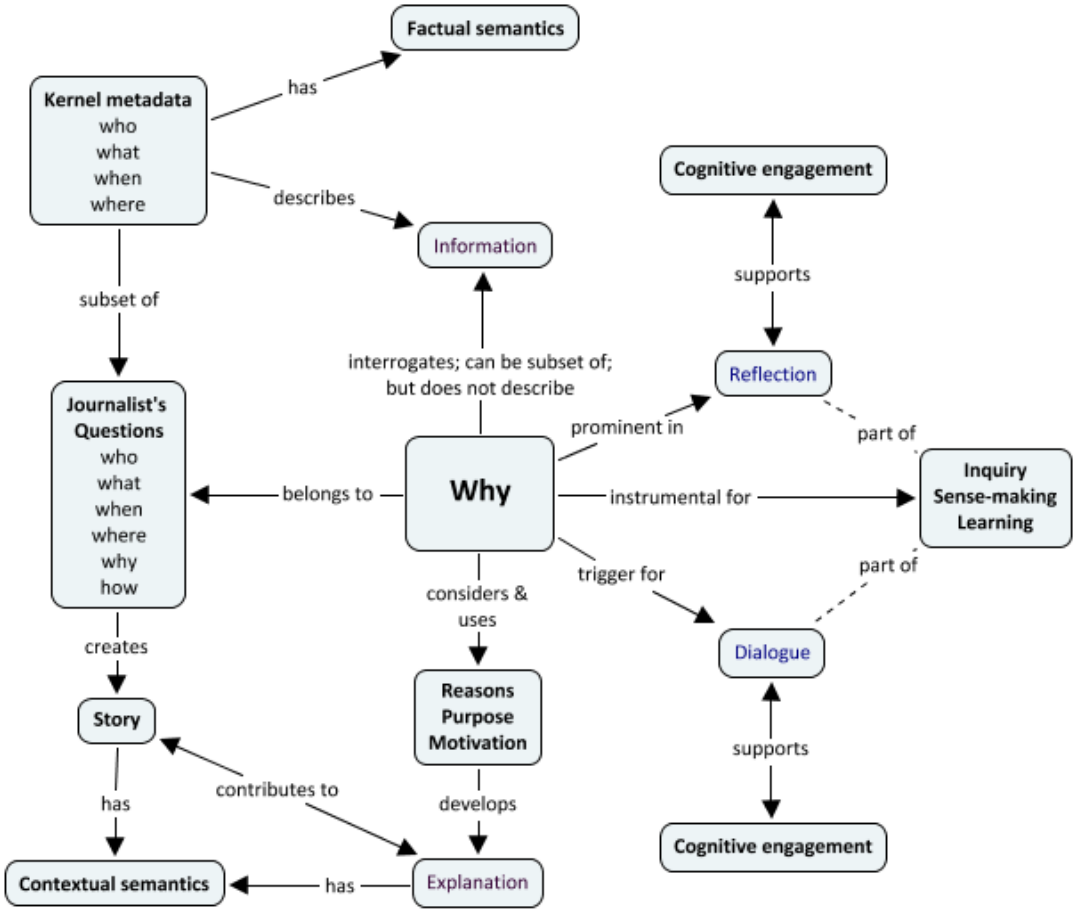


*Figure 1.3.* Concept map of early constructs

Following an initial literature review a conceptual framework was developed that identified five topic domains within which the research questions would be investigated. This conceptual framework was developed as a means to bring coherence to these seemingly disparate topics by setting them against a background theme of the evolution of e-learning and the knowledge modelling that either informs or expresses this evolution. *Figure 1.4* depicts this topic-based framework. Together,

the three abstract models (*Figures 1.2, 1.3,* & *1.4*) serve as a graphic representation of scope that combines the different perspectives.

Rationale for choosing the two central themes and five topic areas as shown in *Figure 1.4* is elaborated upon in the next section immediately following *Figure 1.4*.

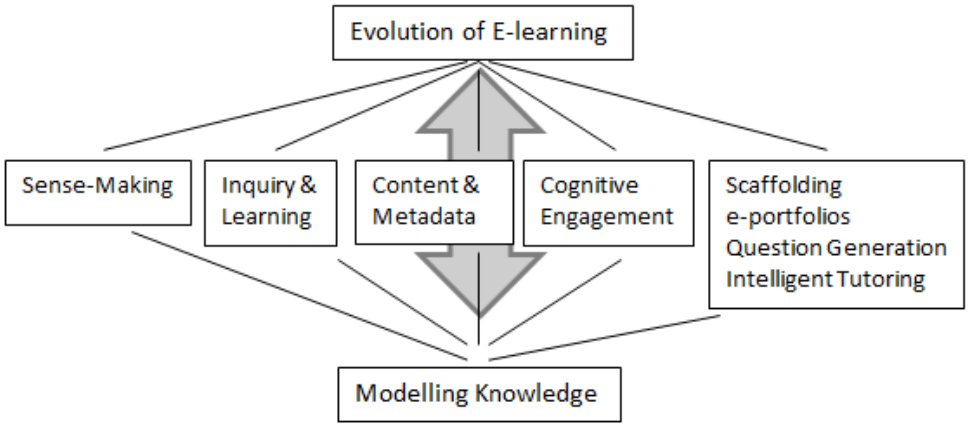


*Figure 1.4.* Central themes and meta-topics of investigation

***Evolution of e-learning and knowledge modelling***

*[These themes appear in papers reproduced in Chapters 2, 3, 4, 5, 6 and 7].*

These two themes are closely associated for the reason that numerous narratives associated with the evolution of e-learning link conceptions of *learning* and *knowledge* as "key pillars" of the digital age and used as constructs in a diversity of ways (Lytras & Sicilia, 2005, p. 3; Norris, Mason, & Lefrere, 2003; Marshall, et al, 2003; Schmidt, 2005). This is summarised well by the graphic shown in *Figure 1.5*.

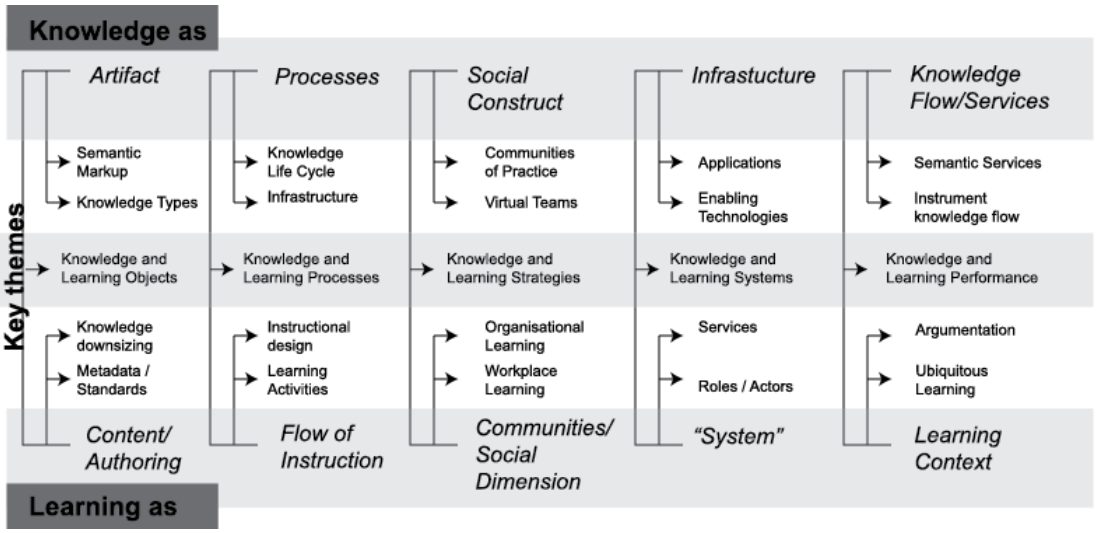


*Figure 1.5* Knowledge and learning as key pillars of knowledge society (Lytras & Sicilia, 2005) © Inderscience

Historical perspective on the ongoing evolution of e-learning is introduced to situate a key narrative of this thesis, namely, that digital technology enables inquiry-based learning. The intention is not to overstate the significance of such a narrative but to place it alongside other significant narratives that characterise the 'digital revolution' in educational contexts as "disruptive" (Halverson & Smith, 2009; Conole, De Laat, Dillon, & Darby, 2008; Laurillard, 2006), "transformational" (Norris, Mason, & Lefrere, 2003; Zhang, 2003; Garrison, 2011), profoundly networked (Siemens, 2004; Seufert, Back, & von Krogh, 2003), and as a natural consequence of an evolving "open agenda" in which the promotion of 'open educational resources' has gathered significant momentum in recent years (Leeson & Mason, 2007; OECD, 2007). Through situating this thesis in this way a gap in both theory and practice is exposed thereby highlighting the context for the contribution of this thesis.

***Sense-making***

*[This topic is introduced in Chapters 3 and 6 with a full discussion this topic elaborated upon in Chapter 9]*.

Making sense of things is a fundamental act a person does when trying to understand something, discern the meaning and implications of a text, identify patterns or relationships, or while learning. Asking *why* is often integral to this act, as is represented clearly in *Figure 1.3*. This topic domain aligns with the theme of knowledge modelling identified as the second research question.

Terminology has been purposefully selected in this thesis. In this case, the term *sense-making* can be seen as terminology with high utility used to describe formal methodologies in academic discourses such as communications (Dervin 1998), management (Weick 1995), complexity (Snowden 2002), and information systems (Sharma 2010). Dervin (2005), for example, conceives of her "Sense-Making methodology …as a mandate of the human condition" (p. 27). It is also a term that has begun to appear in mainstream e-learning reports such as *The Horizon Report:*

> The abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators in sense-making, coaching, and credentialing. (Johnson et al., 2010, p. 3)

This term is shown to be useful in explicating the why dimension, as is summarised by Weick:

> The concept of sensemaking is well named because, literally, it means the making of sense. Active agents construct sensible, sensable … events … They 'structure the unknown' … How they construct what they construct, why, and with what effects are the central questions for people interested in

> sensemaking … [importantly] Sensemaking is grounded in both individual and social activity. (Weick 1995, p. 4-6)

As is discussed in Chapters 9 and 10, an important contribution of this thesis is that *sense-makin*g has broader scope than *meaning-making*, a term that is typically associated with constructivist literature (Hein, 1999). Distinction between these two terms is also provided in the terms and definitions listed in *Table 1.2*, although it is sense-making that is highlighted in this thesis as an important process during learning and the construction of knowledge.

***Inquiry and learning***

*[This topic is elaborated upon in Chapters 4, 5, 7 and 8].*

Linking the sub-topics of inquiry and learning is pivotal to the central narrative that presents the evolution of digital technology as conducive to inquiry-based learning. As distinct activities, inquiry and learning both often involve questioning, though there also exist instances or contexts where questioning may not be present – for example, in rote learning or in initiating a search query using Google. Sometimes, the boundaries between inquiry and learning might be difficult to discern, and in the case of inquiry-based learning they are closely aligned: while inquiry can just involve information seeking it is when it takes place in the context of learning that conscious attention and metacognition take place. Probing the role of questioning – in particular, *why*-questioning – in inquiry-based learning addresses the research sub-question in relation to understanding the role of inquiry within learning theory. It is also fundamental in providing historical perspective on the evolution of e-learning and where future opportunities for development might arise.

***Content and metadata***

*[This topic is introduced in Chapter 3 and given full attention in Chapter 5].*

Content is not only the primary object of learning and research but it also represents a key component that can and must be modelled in the development of digital technology (as represented in *Figure 1.2*). Metadata – data that describes or identifies content, other data or indeed any object in the natural world as well as the digital domain – takes many forms in the digital domain: as formal, standardised schemas used to describe learning resources, as XML tags, as folksonomies (collections of tags assigned to content) generated by communities of practice, as analytics associated with websites, as a Google index of hyperlink weightings, or a cue that may indicate a content type (such as '*pdf*'). The hyperlinking architecture of the World Wide Web is itself a form of metadata and so digital content has a particularly close relationship to metadata.

However, while content may represent a simple component of digital learning complexity arises in its modelling as a consequence of metadata that is used to describe and identify it – this is because an instance of metadata may also be an instance of content (Mason, Norris, & Lefrere, 2003).

Metadata schemas are defined for purposes of managing content for retrieval and discovery purposes and are expressed as structured collections of terms with formally defined semantics and syntax. Because the core or "kernel" semantics of many metadata schemas can be reduced to the semantics of *who, what, when,* and *where* – which also belong to an extended set of *primitive questions* that includes *why* – the question arises *how might learning content that is relevant to why-questioning be managed, discovered and shared?* Some of the key concepts and propositions associated with this topic are represented in *Figure 1.3*.

***Cognitive engagement***

*[This topic is elaborated upon in Chapter 7].*

*Why*-questioning is associated with both reflection and dialogue and is directed toward such things as understanding, clarification, and explanation. There exists an extensive body of literature on the subject of cognitive engagement from diverse fields such as anthropology, psychology, cognitive science, education, information systems, human-computer interaction, augmented cognition, and biometrics in marketing (Naji & Douny, 2009; Henderson et al., 2010; Crawford et al., 2008; Corno & Mandinach, 1983). Much of it is grounded in scientific research. There is also a growing body of contemporary commentary concerned with the detrimental effects of the Internet on our abilities to stay focused – describing it as "the enemy of insight" (Chalupa, 2011, p. 44) and an "ecosystem of interruption technologies" (Doctorow, 2009). For Carr (2010), one of the luminaries credited with first articulating the benefits and inevitability of "cloud computing", the Internet is:

> the single most mind-altering technology that has ever come into general use … when we go online, we enter an environment that promotes cursory reading, hurried and distracted thinking, and superficial learning … The Net's cacophony of stimuli short-circuits both conscious and unconscious thought, preventing our minds from thinking either deeply or creatively. (Carr, 2010)

As is discussed in the relevant paper such a view is both debatable and worthy of further inquiry. What is of significance to this thesis is that cognitive engagement is a construct that is useful when probing *both* deficits and affordances associated with use of digital technology.

***Scaffolding, e-portfolios, question generation, intelligent tutoring***

*[This topic is the focus of Chapter 8. A supplementary paper focused on the sub-topic of e-portfolios was published during this investigation and cited in Appendix A; however, it is not included as a key paper representing the substantive focus of this thesis]*.

This collection of topics spans both digital technology and learning supports as depicted in *Figure 1.2*. Again, however, models can mask complexity and it is often the case that digital technology also provides the scaffolding required to guide and support the learner in the construction of knowledge (Cohen et al., 2004). Because *why*-questioning involves reasoning and problem-solving skills then appropriate scaffolding could feasibly be designed in the form of digital technology.

E-portfolios are identified because in educational settings they are often designed and deployed for purposes of reflective learning and because *why*-questioning has both a reflective and a dialogic dimension to it (Mason, 2011a). It is also the case, however, that e-portfolios serve other functions – such as structured documentation of achievements and so-called 'employability skills' (Baker & Henson, 2010; Mccowan, Harper, & Hauville, 2005).

With regards to question generation it has been noted by Gillies et al., (2012, p. 93) that "teaching students to ask and answer questions is critically important if they are to engage in reasoned argumentation, problem-solving, and learning." From the domain of intelligent tutoring Graesser et al., (2010, p.126), take the argument further:

> Most teachers, tutors, and student peers do not ask a high density of deep questions […] so students have a limited exposure to high-quality inquiry. There are a few role models in school environments through which students

can learn good question asking and answering skills vicariously. This situation presents a golden opportunity for turning to technology to help fill this gap.

Within each of these topic domains the *why dimension* is explored.

**Scope limitations**

A common experience in communicating the research focus to the layperson has been an initial assumption that it must be focused on a computerised means of *answering why*-questions or solving some of the difficult problems in implementing natural language search technology. However, this does not necessarily follow-on from the stated purpose of investigating *why* digital technology provides little explicit support for the *why dimension*. Such a project, that is focused upon *answering why*-questions – fits more closely with research on natural language processing, which has been a shared endeavour of computer science, computational linguistics, and artificial intelligence researchers for many decades and is better left to IBM and well-resourced projects like DeepQA (Ferrucci, 2011). But with this limitation emerges one of the contributions within this thesis: that 'query' interfaces be developed in a manner that support sustained inquiry (for example, questions propagating optional refinements or *consequent questions* instead of answers and thereby supporting cognitive engagement). As is argued in Paper 3, one of the challenges in promoting sustained or deeper inquiry online is the dominance of the "search paradigm", in which inquiry is constrained by fast response keyword and key phrase search techniques.

## Significance

This body of work is significant in a number of ways:

Firstly, in its conceptual reach across theoretical and technical domains it meets an objective of contributing theoretical perspectives upon narratives associated with the problem space from a range of disciplines. This validates Friesen's analysis and argument that e-learning as an academic discipline must be reconceived "as an inter- or cross-disciplinary endeavour" (Friesen, 2009, p. 20) and is consistent with other perspectives from contemporary literature on e-learning (Anderson, 2011; Herrington, 2009).

Secondly, it develops a synthesis of what might constitute appropriate technological responses to the *why dimension*.

Thirdly, it makes conceptual and theoretical contributions to the evolving discourse on e-learning and digital learning through proposing constructs such as *primitive questions*, *consequent questions*, and the *why dimension*; a range of conceptual models that provide broad perspective on positioning the *why dimension* within digital learning; and, in advancing conceptions associated with *knowing-why* and the application of *integrated reflection* and *dialogic learning* to e-learning (Schön, 1987; Wells, 1999).

Additionally, perspectives upon *how* this study addresses issues associated with the advancement of the field in both theory and practice include:

1. Emphasis on the importance of interdisciplinary perspectives in driving discourse and technological innovation. Analysis of the *why dimension* reveals that linguistics, educational theory, information science, developmental psychology, intelligent tutoring, computer science, and knowledge modelling (from various disciplinary positions) all contribute knowledge to the problem of technological support for the role of *'why'* digital learning.

2. Through situating the *why dimension* as a novel, multi-faceted construct within the mix of narratives associated with the evolution of e-learning the interconnectedness of these narratives is demonstrated. In particular, this is elaborated upon in Chapter 5, where the "open agenda" is used as an overarching construct that embraces mainstream discourse on "open" issues related to content, its access and licensing with the notion of "open inquiry" and the movement focused on "21st century skills".

**Terminology**

The terms and definitions listed in *Table 1.2* are used consistently throughout the collection of papers, some of which represent the key constructs of this thesis. Other terminology that is specific to an individual paper is made explicit at the time.

Terminology is a component of natural language and is therefore dynamic, evolving over time. Its construction within (or appropriation for) a particular discourse demonstrates its hermeneutic dimension, subject to interpretation and its pragmatic functions (Bernstein, 1983, p. 30). Terminology is therefore relational and contextual – what may make sense in one context is not necessarily portable to the next and can cause considerable debate. For example, the term *learning* is so commonplace that most people will have a common sense or conventional understanding of what it means; however, in the context of educational psychology and educational theory, Alexander et al., (2009) put forward the case that because this term is "multi-dimensional" it remains a "complex but elusive construct" (Alexander et al., 2009, p. 180). With this caveat, the following terms and definitions collectively represent the sense-making of the researcher are provided for guidance through this thesis when required.

Table 1.2

*Terms and Definitions*

| Term | Definition | Comment |
|---|---|---|
| consequent questions | questions that that arise as a consequence of a focus question | This is an emergent construct arising from the synthesis of arguments for this thesis. |
| digital learning | learning that is facilitated by engagement with digital technology | While this is a similar definition as that for *e-learning* Paper 3 elaborates further and proposes that *digital learning* is a more inclusive term, less burdened by or shaped by the formal context of engagement with learning management systems. |
| e-learning | learning that is facilitated by engagement with ICT | A core construct that Paper 2 elaborates on while discussing other definitions for this term through a historical lens. |
| explanation | a commentary that elucidates or elaborates upon another related statement; an exposition or account of something that clarifies | This term is contrasted with *information* within the collection of papers. Unlike information, an explanation includes some element of story. This thesis makes use of story within its narrative on the evolution of digital learning. |
| explanatory content | content that is characterised by its primary function as being explanatory or explanative | This construct is introduced to distinguish such content from content that is descriptive or factual in function. |
| information | a factual component of knowledge that is uncontested by convention; a representation of data within a context | This term is contrasted with *explanation* within the collection of papers. It is a fundamental building block of content. |
| integrated reflection | in-session reflective practice | Reflection is often depicted as an activity that takes place *after* a learning activity. Following Schön (1987) this conception of integrated reflection refers to a range of activities that embrace discernment, critical thinking, identification of facts and issues, checking, synthesis, reconciliation, summarisation, and pattern recognition while learning. *In-session* indicates an engagement with digital technology, setting time boundaries associated with a session. |

| | | |
|---|---|---|
| knowledge management (KM) | an organisational intervention aimed at improving efficiencies in the handling of knowledge; *and,* an academic discourse concerned with theoretical frameworks and practical techniques for managing the entire knowledge lifecycle from a variety of perspectives: individual, community, and organisational | The KM discourse is replete with models that represent the creation, socialisation, and flow of knowledge, particularly within organisations. Narratives on 'knowledge sharing' and 'knowledge networks' are prominent in contemporary KM literature while early approaches were concerned with the capture and retention of intellectual capital and *know-how* within organisations. |
| learning supports | core input in digital learning (with ICT and content) | Includes inputs from teachers, peers or curriculum support materials. |
| meaning making | construction of knowledge (by individuals or groups) through interpretation of semantics, patterns, and rules | This common construct is used here in distinction to sense-making. It is also an important construct in constructivist literature. |
| metadata | data that describes and/or identifies any object | It is commonly referred to as *data about data*, but such a definition is not precise. In the digital domain content is a meshing of data, information, knowledge, and diverse media types – any of which can function as metadata conditional upon context. |
| open agenda | application of the term *open* in digital learning contexts with other terms that typically convey free access to content, shared intellectual property for the public benefit, and technical interoperability of ICT | Openness is also used in Paper 3 (as *open inquiry*) to indicate the opening of pathways to deeper inquiry through enabling technical support for *why*-questioning. |
| primitive questions | questions arising from one word; *who, what, when, where, why, how, if* | A core construct with seven primitive questions depicted within *Figure 2.1*. Other such questions exist, e.g., *which, will, is,* etc. |
| scaffolding | techniques, tools, and relationships used to assist in the development and maturation of understanding associated with learning | A term that evidence shows has evolved significantly as a consequence of the digital revolution in education. Digital technology itself provides a diverse range of scaffolding. Its broad meaning is as a temporary support that is discarded once understanding is achieved. |
| search paradigm | dominant, fast-response but shallow inquiry techniques | Also referred to as the "fast-food search paradigm of inquiry" in the included papers |
| semantic technologies | technologies developed to manage and parse formally defined semantics | The Semantic Web is supported by many such technologies – e.g., Resource Description Framework (RDF), Topic Maps, and the Web Ontology Language (OWL) |

| | | |
|---|---|---|
| sense-making | making sense of things; reasoning as well as interpreting and understanding | Importantly, this term is broader than the semantics associated with meaning-making and involves reasoning. However, it is not a superset of meaning-making because ascribing meaning is not a requirement for sense-making (see Chapter 10). |
| sense-making technologies | technologies specifically developed for stimulating and supporting sense-making | An emergent construct. Unlike *semantic technologies* that focus on the parsing of semantics these technologies utilise representational capabilities for communications beyond semantics (e.g., simulations) |
| why dimension | asking, learning, understanding, knowing, and explaining *why* | Linguistic versatility brings with it semantic ambiguity and this functions to trigger further inquiry through reflection and/or dialogue |

## Methodology

This thesis has been developed using the *Thesis by Published Papers* pathway offered by Queensland University of Technology. The chosen methodology for the investigation has been to complete a comprehensive transdisciplinary literature review with the goal of synthesising novel constructs that would stimulate discourse and contribute new knowledge, informing the development of both the theory and practice of e-learning. The rationale for doing so has been that the sequential publication of papers would provide an appropriate peer-reviewed mechanism for the progressive development and testing of proposed constructs and emergent knowledge.

It is important here to also make explicit that while this investigation has been conceptual in character it has been motivated by a strong passion to contribute new knowledge based upon initial insight about the role of *why* drawn from *practice* in the domain of e-learning that has incubated for a few years prior to commencement of this structured study – in other words, it has been informed by engagement with

technologies that have driven the evolution of e-learning. There is, therefore, a phenomenological base (subjective experience) from which the methodology has originated (Smith, 2007; Husserl, 1929).

From initiating this investigation the sequential steps regarding methodology involved were as follows:

1. An initial literature review was completed that identified significant theoretical perspective and analysis on the core topic of *why*-questioning from diverse disciplines – such as education, educational psychology, linguistics, information science, anthropology, and computer science. A noticeable gap existed within the discourse associate with e-learning.
2. Concept maps were developed to identify key concepts that would guide further conceptualisation and coherency of approach (see *Figures 1.2, 1.3*).
3. Topic domains for research were identified (*Figure 1.4*) and together with the central themes of the *evolution of e-learning* and *knowledge modelling* these formed a conceptual framework for the production of papers.
4. A focused literature review associated with each of the five topic domains (in relation to the central themes) was conducted in the development of each paper.
5. Transdisciplinary perspectives were considered and a number of constructs developed and considered and evaluated consistently throughout the development of each paper.
6. A concluding chapter of this thesis was developed to present a condensed synthesis of the contributions made.

In terms of ensuring conceptual rigour would be achieved and arbitrary conceptualisation avoided, extensive research on appropriate paradigms and epistemological approaches was also conducted. The following discussion elucidates this.

**Paradigms and emergent perspective**

Established paradigms in educational research – typically classified as either *positivist, critical, interpretive*, or sometimes as *naturalistic inquiry* and *postmodern* – create a means of situating research within an established discourse that provides sufficient *explanatory* and contextual coherence through use of accepted terminology and tested constructs (Cresswell, 2008; Patton, 1990; Dash, 1993).

This thesis does not sit completely *within* any of the established traditional paradigms of educational research noted above, although it is closest to an interpretive paradigm. Instead, this thesis endeavours to reach across and draw from all of them and, as such, could be described as *multiparadigmatic* (Taylor & Medina, 2013). This approach has been taken in response to the appropriation of the term *paradigm* and ubiquity of the phrase *shifting paradigms* within the discourse communities relevant to this investigation (Hey, et al., 2009; Desai, et al., 2008; Garrison, 2011; Liu & Hwang, 2010). A pertinent example is Wierzbicki and Nakamori (2006, p. 1-13) who note a change in paradigms within the knowledge sciences from the "principle of reduction" to the "principle of emergence" which is identified as coincident with the beginnings of a "new informational knowledge civilization era" from around 1980. Such a perspective is common throughout a diverse body of contemporary literature; and can be understood partially as a consequence of the emergence and development of the digital technology enabled global information infrastructure over the last few decades which represents nothing less than a profound re-configuration of social, economic, and technological structures with networks driving both innovation and disruption (Benkler, 2006; Castells, 2001). This "principle of emergence" is important in this body of work for the following reasons:

1. This thesis is concerned with the evolution of e-learning (origins, inputs, contemporary practice, emergent and plausible futures).
2. Many examples exist within the literature that characterise *e-learning* as an emergent field that is also complex, adaptive and self-organising (Williams, et al., 2011; Cooper, 2010; Kukulska-Hulme & Pettit, 2009; Sims, 2008; Irlbeck, et al., 2006).
3. The *why dimension* is an emergent construct central to this thesis.

**Epistemological approach**

Following these perspectives on paradigms, declaring a single theory of learning or epistemology that underpins this thesis is not justified. Research methodology is also shaped by epistemological and ontological positions and assumptions concerning the nature and dimensions of knowledge, its relationship to reality, what constitutes valid knowledge, or the domain under investigation. Like science, these branches of philosophy are concerned with open inquiry and validated evidence; and, like science they inform the construction of theories about observed or perceived reality. The primary resources of philosophy, however, are conceptual and contestable only in terms of rational argument; and, as a consequence of epistemological and ontological assumptions, shared concepts (and even shared terms and associated definitions) do not necessarily lead to shared understandings. This can become problematic within an interdisciplinary context, particularly where core constructs that may be common to different disciplines have different meanings. Thus, for example, *ontology* itself is a term that is understood differently by different discourse communities. While it may have originated in philosophy to refer to metaphysical questions of *being* in the world (Husserl, 1929) it is also a term used commonly within computer science to refer to a "formal, explicit specification of a shared conceptualization" (Gruber, 1993) that functions as a relational, semantic

taxonomy typically constrained to be domain specific. Ontologies, thus defined, are used in computer systems for the purpose of enabling semantic interoperability, enabling the discovery, aggregation, and exchange of content that is semantically related.

Describing this same challenge from the "multidisciplinary" field of information science Becker & Niehaves (2007, p. 197) observe that "working on the same research topic or studying the same phenomenon does not necessarily ensure mutual understanding." For this thesis there has been an added challenge. Because knowledge modelling is a core consideration to be researched then issues of epistemology, in particular, can complicate the task of making epistemological and ontological assumptions or positions explicit. In other words, there is some element of recursion (something being defined in terms of itself). While recursion is not necessarily an intractable problem, and is used as a powerful algorithmic technique within computer science (Laplante, 2001, p. 411), it does add complexity that is not apparent in the concept maps represented in *Figures 1.2* and *1.3*. To the question *'what constitutes valid knowledge?'*, therefore, must be a response that has considered the facets of knowledge and the various approaches to classifying or modelling knowledge discussed and represented within the papers of this thesis.

Following Jakubik (2011), this thesis addresses these issues by adopting an "epistemology of becoming" involving an ongoing "ontological and epistemic chain" of "becoming to know" in which processes of engaging, becoming, knowing, and learning are inter-meshed through sense-making processes of *knowing-why* and practical *know-how* (Jakubik, 2011, p. 381). This epistemological approach has informed both the content and the process of this thesis and is represented in *Figure 1.5*. In terms of content, key constructs used in *Figure 1.5* (in particular, *learning, becoming, knowing, sense-making,* and *know-why*) map closely to the core constructs

used throughout the collection of papers. In terms of process, the iterative nature of drafting, writing, responding to peer-review, editing, and synthesising has been a process of *becoming to know* through numerous cycles.

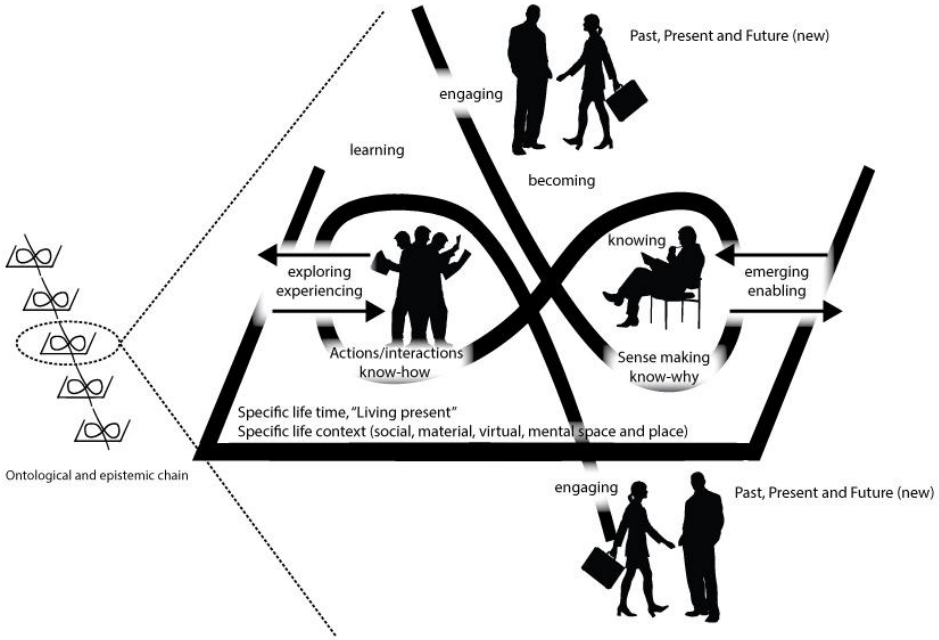


*Figure 1.6.* Becoming to know. Adapted from Jakubik (2011)
original graphic © Emerald Publishing

Such an approach also aligns well with prior work of Cook & Brown (1999) in which *knowing* as an "epistemology of practice" is given emphasis over an "epistemology of possession" in which the "traditional understanding of the nature of knowledge… treats knowledge as something people possess" (p. 381).

**Hermeneutics**

As a philosophy of inquiry, hermeneutics also informs the methodology of this thesis. Following Heidegger's (1927) exposition of ontology as phenomenological, pre-scientific and always subject to interpretation, Friesen et al, (2012, p. 2) characterise hermeneutics "as the art and science of interpretation" in which "we are compelled to ask questions" of phenomena and ontology. Heidegger used the

concept of the "hermeneutic circle" to describe the reflexive and reflective nature of interpretation that must necessarily proceed in cascading stages, in which there is a mutually informing process between an emerging whole and its situated parts. The tradition of hermeneutic phenomenology that has since developed from Heidegger's philosophy places emphasis upon the phenomenology of existence and experience Gadamer (1977; 1989). It has also been characterised as having "a special affinity to education" (Jardine, 2006, p. 269), and been adopted as a coherent methodological approach for educational research (Friesen, et al., 2012); however, this thesis does not probe deeper into these positions or issues arising. Nonetheless, the concept of the hermeneutic circle provides guidance on interpretation of the contribution of this thesis, in which each discrete paper provides perspective upon the body of work in aggregate, yet also needs to be understood from an emergent whole. Such a position is important to make explicit here because "hermeneutics does not begin its work by beginning with method" (Jardine, 2006, p. 272). Thus, while a robust methodology may be associated with any claim of new knowledge this hermeneutic perspective must also be accommodated in evaluating the findings herein. As such, *inquiry* is both the object and the method.

### Mode 2 knowledge

The term "Mode 2 knowledge" was coined by Gibbons et al. (1994) to describe a "new form of scientific research knowledge" to emerge in the late 20$^{th}$ century that is intrinsically transdisciplinary:

> Mode 1 [research] problems are set and solved in a context governed by the, largely academic, interests of a specific community. By contrast, Mode 2 knowledge is carried out in a context of application. Mode 1 is disciplinary while Mode 2 is transdisciplinary. Mode I is characterised by homogeneity,

> Mode 2 by heterogeneity. Organisationally, Mode 1 is hierarchical and tends to preserve its form, while Mode 2 is more heterarchical and transient. Each employs a different type of quality control. In comparison with Mode 1, Mode 2 is more socially accountable and reflexive. It includes a wider, more temporary and heterogeneous set of practitioners, collaborating on a problem defined in a specific and localised context.
>
> (Gibbons et al., 1994, p.3)

This conception is introduced here as it aligns closely with the preceding philosophical perspectives concerning methodology concerning paradigms, epistemology, and hermeneutics. Because e-learning has been shown to draw from numerous disciplines then the knowledge bases associated with it can be described as conforming to "Mode 2 knowledge production" as outlined by Gibbons, et al. (1994) and adopted by others in more contemporary literature (Manathunga, Lant, & Mellick, 2006, p. 365).

**Structure of the thesis**

The following chapter provides a brief outline of each paper, its rationale for inclusion and main contributions. Each paper is then presented as a separate chapter, and is followed by a summary of key contributions made to this thesis. A concluding chapter follows that summarises the contributions made, drawing them together, with added commentary and reflections on the constructs used throughout.

# Chapter 2: An Overview of the Papers

Five published papers and two manuscripts accepted for publication in edited volumes comprise the main part of the body of work representing outputs of this investigation. Reference is also made to six further published papers that were produced during the investigation (see Appendix A).

This overview chapter discusses the key contributions of each paper within the main body of work and how it is connected to the main theme. This outline is provided as part of the "hermeneutic cycle" – to introduce the reader to how each of the papers interconnects before focusing on each paper as its own coherent piece of work. It is noted here that sequence does not follow an exact chronological order, the reason being that the adopted order provides more narrative integrity. While a strict chronological sequence may show the development of conceptualisation over time this is not considered to be of primary consequence here where the ordering of papers is more concerned with overall narrative integrity. In particular, Paper 2 is sequenced early as Chapter 4 because of its use of scenarios to motivate understanding of the problem space.

Discussion associated with each paper here is further elaborated upon in Chapter 10, *Reflections and Conclusions* – again, as part of the hermeneutic cycle.

**Paper 1 – A Model for Sense-Making**

Mason, J. (2008a). A Model for Sense-Making: Exploring *Why* in the Context of Learning and Knowing. *The 16th International Conference on Computers in Education*, 1, 545-549.
http://www.apsce.net/ICCE2008/papers/ICCE2008-paper286.pdf

This first paper, published during the early stages of PhD candidature, proposes a sense-making model (see *Figure 2.1*) that represents an initial construct that includes seven *primitive questions* – that is, questions arising from the single words: *who, what, when, where, why, how,* and *if*. It is acknowledged that while other such primitive questions exist (for example, *which, will,* and *can*) the set of seven identified questions are highlighted because of their close connection to representing key facets of knowledge (*know-who, know-what, know-when, know-where, know-why, know-how,* and *know-if*). In this model, a close relationship between processes of thinking, learning, and knowing are represented. As an initial construct this representation aligns closely with the core of Jakubik's (2011) "epistemology of becoming" as represented in *Figure 1.5*, a construct that emerged during later research and is discussed in *Paper 7* (Chapter 9).

The sense-making model is identified as common to two key intersecting discourses and domains of practice: knowledge management and e-learning. Knowledge management is conceived as both an organisational intervention and an academic discourse while e-learning, likewise a term referring to practice and discourse, is represented as developing largely from rapid innovation in information and communications technology (ICT). Both discourses are shown to have emerged in the wake of "an increasing interconnectedness of entities (human, organizational, and technological) that can share and exchange data, information, and knowledge" (Mason, 2008a, p. 545; Mason 2008b). Intersection of these discourses can also be

seen where there is recognition that knowledge is a commodity that can underpin socio-economic growth and is supportive of lifelong learning, continuous professional development, and performance support through digital technology as an alternative to traditional face-to-face models. Both domains of practice are shown to intersect in terms of ICT that is used to support the management of content; and both domains of practice are sustained by the interconnection of "content, community, and context" (Mason, 2008a, p.547; Seely Brown, 1999, p. ix).

This paper also establishes linkages between core constructs of this thesis: *primitive questions*, *why*-questions, metadata, sense-making, and the evolution of ICT infrastructure that supports both e-learning and knowledge management. Specifically it highlights '*why'* as a primitive question important in sense-making but a question that is not well supported by ICT utilised by e-learning and knowledge management.

Concluding statements establish the sense-making model as sufficient basis for further research: "to help distil and explain the relationships between networks, metadata, learning and knowledge management [and] … to inform … future development of ICT infrastructure and services relevant to e-learning and knowledge management". The limitation of this paper, however, is in its assumption that *answers* associated with *why* questions is where research "might then inform the development of rich scaffolding to enable learners to probe deeper into a subject domain while engaging in e-learning." As will be shown in later papers that focus on issues of deep inquiry, cognitive engagement, and scaffolding, the process of *sustained questioning*, in which *consequent questions* play a key role, is proposed as a means of scaffolding the natural human disposition to ask and discuss *why* – rather than focusing on the *answers* to questions as the endpoint.


*Figure 2.1.* A sense-making model for thinking, learning, and knowing (Mason, 2008a, p. 547).

**Paper 2 – Theorizing *Why* in e-Learning: A Frontier for Cognitive Engagement**

Mason, J. (2012a). Theorizing *Why* in e-Learning – A Frontier for Cognitive Engagement. In D. Sampson, J. M. Spector, D. Ifenthaler, & P. Isaias (Eds.) *IADIS International Conference on Cognition and Exploratory Learning (CELDA 2012) Proceedings* pp. 57-64.

This paper is sequenced as second because it makes use of a set of different but common scenarios from educational contexts to motivate the rationale for probing into this topic. It also spans the broad conceptual framework of *Figure 1.4* by connecting the topic domains of inquiry and learning, content, cognitive engagement, and scaffolding in relation to the evolution of e-learning. It is explicit in its approach to theorizing and it elaborates on the central topic of *why* by utilizing a number of typical contemporary scenarios involving the use of ICT for learning – describing contexts for a university student, a high school teacher, an instructional designer, and a teacher librarian; which, despite contextual variance, all share common requirements: consideration of accommodating *why*-questioning along with goals of understanding, learning, explaining, or teaching *why*. It then provides some historical perspective for the evolution of e-learning and identifies a number of different narratives that interpret this evolution.

The concept of the *search paradigm* is introduced in the paper as a key factor shaping the four scenarios presented and as the "the key operator on, and organizing technology for, content" (Mason, 2012, p. 61). It is also presented in relation to contemporary literature that characterises IT as an "interruption technology" (Carr, 2010) and points to the deficits of digital technology in terms of not adequately being conducive to supporting cognitive engagement beyond short attention spans. The search paradigm is characterised in terms of being a dominant, powerful, but also shallow means of technology enabled inquiry that supports e-learning. In proposing a counterpoint the paper suggests that deeper probing of content, or "deeper inquiry" is something that *why*-questioning can initiate and maintain.

This paper introduces the notion of the "dimensions of why" and provides a review of pertinent literature from linguistics (Evered, 2005), philosophy (Walton, 2004), intelligent tutoring (Graesser, et al., 2007), anthropology (Goddard & Wierzbicka, 2007), computational linguistics (Verberne, 2010), philosophy of education (Dewey, 1966), educational psychology (Piaget, 1966), educational theory (Schön, 1987), artificial intelligence (Schank & Cleary, 1995), and inquiry-based learning (Bruce & Casey, 2012). Following this, five key activities associated with *why* and relevant to e-learning are identified as *asking, learning, knowing, understanding*, and *explaining why*. This is the first explicit instance that the construct of the *why dimension* is emerging, although is not named as such in this paper. These five activities can also be seen to collectively represent key facets of *sense-making* and can be applied to other primitive questions identified in the Chapter 3. Additionally, while not made explicit in this paper, subsequent reflection indicates that these activities, as aspects of sense-making, support cognitive engagement.

In providing a historical narrative associated with the evolution of e-learning this paper positions the "dimensions of why" as an important frontier for the application of technological innovation. The paper concludes that investigations into the theoretical dimensions of *why* reveal there are significant repercussions for the design, development, and utilization of ICT systems aimed at supporting e-learning. In particular, accommodating the multiple activities associated with *why* – asking, learning, knowing, understanding, and explaining – points to a frontier that will focus on the pivotal role of *explanatory content* and prolonged cognitive engagement through reflective practice.

**Paper 3 – Opening Digital Learning to Deeper Inquiry**

Mason, J. & Pillay, H. (2013-accepted). Opening Digital Learning to Deeper Inquiry. In Mohamed Ally & Badrul Khan (Eds.), *The International Handbook of E-learning*. Athabasca University Press.

This paper (to be published as a book chapter) brings together two interrelated narratives: the evolution of e-learning (also *digital learning*) and a prominent parallel or intersecting narrative inclusive of a growing number of '*open*' initiatives and movements dominated by themes associated with access to content, intellectual property, public benefit, sharing and technical interoperability. This second narrative is summarised by a construct termed the *open agenda* following Leeson and Mason (2007) and is a narrative that is commonly found both within and outside the discourse on e-learning. Concepts associated with *openness* are explored in terms of historical origins and how the *open agend*a can be viewed as a natural place to position inquiry-based learning and is summarised in Table 2.1.

This paper broadens the *open agenda* to be inclusive of opening pathways into *explanatory* content for inquiry and deeper learning and is consistent with

contributions made to educational theory by Dewey (1910) and Montessori (1949) in which openness is associated with a student-centred pedagogical approach to inquiry. This is highlighted as significant in terms of close alignment with the affordances of digital learning which enable the proliferation of learner choice of time, place, and provider of learning resources and terms that describe this such as "flexible learning" and "self-directed learning" (Mason & Pillay, 2013, p. 5; Collis & Moonen, 2002; Van den Brande, 1993; Song & Hill, 2007; Garrison, 1997).

Table 2.1

*Openness, Society and Learning*

| Term | Associated Meaning | Origins |
|---|---|---|
| Open Learning | Independent, inquiry-based, and self-determined learning | John Dewey (1910)<br>Maria Montessori (circa 1911) |
| Open Society | Democratic governance, transparent government, and respect for human rights | Henri Bergson (1932) & Karl Popper (1945)<br>Advocated by George Soros with formation of Open Society Institute (1993) |
| Open Architecture | Extensible infrastructure (of the Internet) | 1969 (ARPANET)<br>International Organization for Standardization (ISO) Open Systems Interconnection (OSI) Model |
| Open University | No academic prerequisites to entry; use of ICT including radio and broadcast television for distance learning and e-learning | 1971 (UK Open University) |
| Open Standard | Indicates that the process of development is transparent; the standard promotes *interoperability*; is publicly available; but intellectual property may be preserved | Mid 1980s |
| Open License | Typically non-commercial access to content and/or software | Richard Stallman and the GNU Project (1983)<br>Developed by Creative Commons (2001) |
| Open Source | Shared *intellectual input* into the development of software with specific but royalty-free licensing requirements | The term appeared in 1998 but roots of sharing software code date back to the beginnings of the Internet |
| Open Knowledge Initiative | Interoperability specifications | Massachusetts Institute of Technology (2001) |
| Open Courseware | Free access to structured, quality courses and content | Massachusetts Institute of Technology (2002) |
| Open Access | Royalty-free publication and dissemination of content (typically academic research) | The Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (2003); arXiv.org influential (1999) |
| Open Content | Content that can be freely used and modified by others | David Wiley (1998) |
| Open Scholarship | Sharing intellectual endeavour and outputs | Can be traced to origins of arXiv.org with repository initiatives such as the Los Alamos National Laboratory |

| | | |
|---|---|---|
| Open Educational Resources (OER) | Educational resources (content, digital tools, and standards) developed for free public access and use. | The term OER emerged in 2005 but content developed specifically for the public good or the "public commons" has been happening for centuries |
| Open Teaching | Being explicit and transparent about teaching methodologies | Diana Laurillard (2008) |
| Massive Online Open Courses (MOOCs) | Online learning involving large numbers of participants. | 2008. George Siemens and Stephen Downes deliver online course called "Connectivism and Connective Knowledge" |
| Open Data | Linked closely with Open Government; key drivers are public benefit and public ownership of publicly-funded data collection | 2010. Can also be linked back to the Open Archives Initiative (2000) and the protocol for exposing metadata records for reuse |
| Open Digital Learning | Digital Learning that combines meanings associated with OER together with emergent dimensions, such as inquiry, assessment, participation, and dialogue | Emerging now.<br>Builds on OER with "new kinds of open participatory learning ecosystems" (Seely Brown & Adler, 2008) |

In providing an account of the evolution of e-learning issues of terminology are raised, particularly the problematic nature of the term *e-learning*. Evidence suggests that *digital learning* has less semantic ambiguity associated with it and has broader long-term utility in that it comfortably describes learning via all kinds of digital technology devices that are built primarily for other purposes – such as games for entertainment or navigation through GPS – as well as learning with mobile devices. As such, digital learning subsumes both *e-learning* and *m-learning* (a shorthand version of mobile learning which ambiguously associates mobility with the learner, the content, and the devices used to access the content. *Figure 2.2* is introduced as a timeline of milestone inputs into *digital learning* enabled by the *digital revolution*.

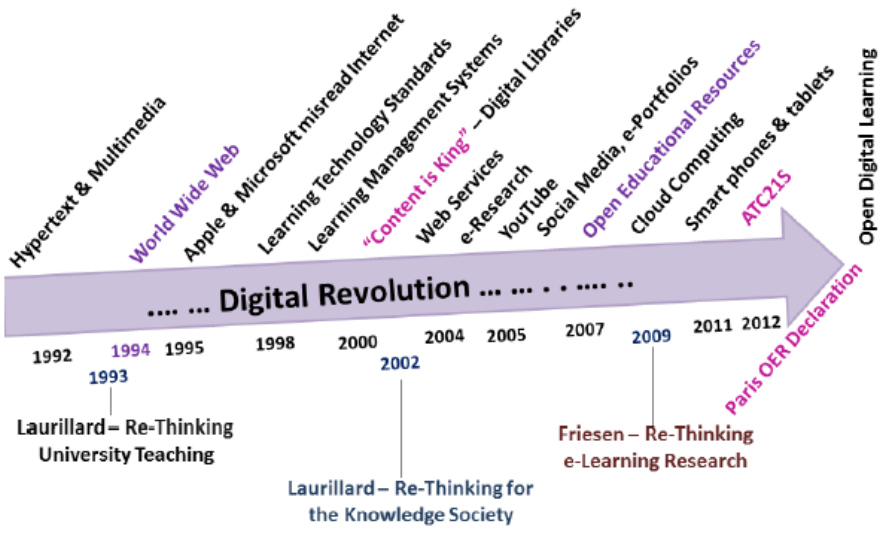


*Figure 2.2.* Inputs into digital learning. (Mason & Pillay, 2013-accepted)

Aligned with the milestones represented in *Figure 2.2* are a number of narratives associated with the evolution of e-learning. Among them are themes such as the transformation of education by a global informational infrastructure (Dolence & Norris, 1995; Castells, 2001; Benkler, 2006), emergence of a *knowledge age* through innovation in knowledge sharing technologies (Norris, et al., 2003), empowerment of the individual in terms of the place and time of learning (Goodyear, et al., 2001), democratisation of media and content production with the rise of social media (Manovich, 2009; McLoughlin, & Lee, 2007), and the development of technologies conducive to self-directed and inquiry-based learning (Laurillard, 2006; Beetham & Sharpe, 2013; Song & Hill, 2007). This paper contributes to this discourse on digital learning by putting forward a sound case that future innovations in digital technology could be informed by focusing more upon processes of inquiry and sense-making and less upon content. It proposes that inquiry instigated by *why*-questions, in particular, provide a direction for the evolution of digital learning. The rationale for this is made explicit as follows:

1. Technologies that support information-seeking are ubiquitous and available at the fingertips of anyone with a smartphone or other mobile technology – but they are not sufficient for scaffolding deeper inquiry.
2. Information-seeking is typically a first step to inquiry and a key activity of learning. Importantly, information-seeking only seeks a clear or factual answer to a search query.
3. In direct contrast to the primitive questions of information discovery – *who*, *what*, *when*, and *where* – *why* is a term that has ambiguous semantics. As such, it presents problems for data mining tools and search engines.
4. Inquiry instigated by *why*-questioning typically seeks a plausible explanation, a rationale, or elaboration as a response, not just information. As such, it is instrumental in stimulating or continuing a dialogue or interaction with other humans or devices. Importantly, *why*-questioning does not necessarily seek factual answers.
5. To ask *why* is to make sense of something. Thus, sense-making tools (textual and visual) may prove to be more effective than the dominant search paradigm of information-seeking when adequate responses to *why*-questioning are sought.
6. To learn *why* involves processes of reasoning, meaning-making, acquisition of knowledge, and the development of understanding. Thus, tools that support these processes would be useful for digital learning.
7. To explain why can invoke reasoning, storytelling, and reflection upon motivation, purpose and context – all activities so important to metacognition and deeper learning. Explaining why can demonstrate understanding or lack of it. Thus, tools that support the development of explanatory techniques would be useful for digital learning.

   (Mason & Pillay, 2013, p.8)

**Paper 4 – Knowledge Management and Dublin Core**

Mason, J. (2009). Knowledge Management and Dublin Core. *Proceedings, International Conference on Dublin Core and Metadata Applications* (pp. 41-50). http://dcpapers.dublincore.org/ojs/pubs/article/view/953/950

For the reader reading each paper in sequence this paper represents a temporary departure from the narrative focused mostly on e-learning; however, it is placed in this position because it speaks directly to the first research question: "*Why does the convergent ICT infrastructure provide no explicit technology support for 'knowing why' in knowledge management and 'asking why' in e-learning?*".

This paper is focused on conceptual and technical issues associated with adequately representing knowledge for the digital domain and framed in terms familiar to the discourse community it is prepared for (an international association of internet metadata experts). As such, it is concerned with how digital content is described, managed, and discovered. It uses the concept of *kernel metadata* – core semantics of metadata that can be reducible to four facets, *who, what, when* and *where* – as a point of focus (Kunze, 2001). *Figure 2.3* illustrates this concept in the case of a simple citation in which each facet has a *descriptive* function.

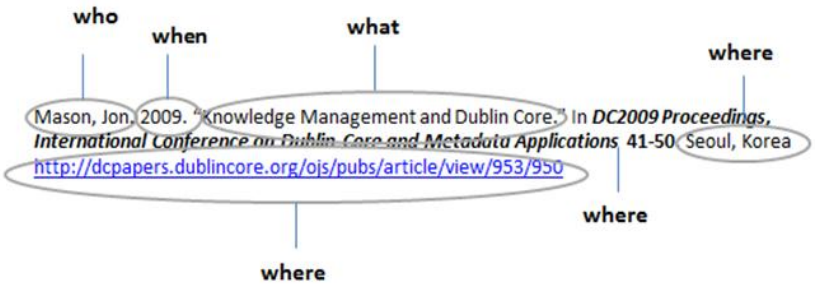


*Figure 2.3.* Core semantics of a citation.

The paper also makes use of the sense-making model represented in *Figure 2.1* of this thesis, highlighting seven *primitive questions* (*who, what, when, where, why,*

*how*, and *if*) – with *how*, *why*, and *if* discussed as extending beyond the semantic constraints of kernel metadata. *How* and *if* are discussed in terms of procedural and rule-based knowledge leaving *why* as presenting "a significant challenge to deeper modelling". A limitation on the efficacy of this early modelling, however, is indicated due to its circular representation – citing recent literature focused on identifying transitions in knowledge creation in which most models are typically presented as spirals (Wierzbicki & Nakamori, 2006; Mason, 2009, p.45). Therefore, in terms of the epistemological framework, *'becoming to know'* adapted from Jakubik (2011) and represented in *Figure 1*.5, further refinement of this model could be undertaken to better express movement through time as *becoming*. This is significant in that the *why dimension* indicates activity or enactment – not just information nor procedure nor rules.

The paper is also framed around the knowledge management (KM) discourse in which Dublin Core (DC) metadata is shown to have application. A comprehensive definition of KM is advanced as: "both an organisational intervention aimed at delivering better efficiencies in the handling of knowledge, and an academic discourse that develops theoretical frameworks and practical techniques for managing the entire knowledge lifecycle from a variety of perspectives: individual, community, and organisational" (Mason, 2009, p. 42). This particular discourse is also used for the primary purpose of investigating the potential future scope for the development of metadata that embraces *why* in KM contexts. For example, a metadata term for *rationale* (*knowing-why*) included within a metadata schema could be where explanations concerning *why* organisational procedures are framed and implemented the way they are, is the kind of knowledge that can assist in the development of "strategic insight" (Mason, 2009, p.45).

This paper has a strong connection with the background theme of knowledge modelling and a variety of models is presented showing relationships between data, information, and knowledge – in which digital content is conceived as a meshing of data, information, and knowledge – together with various approaches to classifying and representing knowledge (Mason, 2009, p. 42-45). These models are also elaborated upon in Chapter 9 from the perspective of sense-making.

Issues associated with organising information as opposed to organising knowledge are analysed. Practical perspective is provided through reference to real-world implementations and projects providing evidence of how metadata is currently deployed in educational settings. *Figure 2.1* is discussed as an abstract model that both validates current applications and points to potential novel applications of metadata in which the *explanative* domain is advanced as a potential area to develop because of the functional value it would provide. This idea of an *explanative* function contrasts starkly with the typical *descriptive*, identification, and technical functions of metadata schemas. While not elaborated on in detail in the paper, such models are only a first step prior to the development of data models and domain-specific ontologies required for system interoperability to be realised (Mason, 2009, p. 46).

Thus, following on from the Singapore Framework (Nilsson et al., 2008), an agreed methodology within the DC community for specifying metadata, this paper has been explicit about the conceptual foundations in modelling a domain of activity, in this case, knowledge management. This contribution can be seen as an important step prior to developing any metadata schema. While the paper does not proceed to the next step and propose *how* it should be best specified, it advances the case for defining metadata schemas that can provide an *explanatory* as well as a *descriptive* function. If such an approach were to be pursued then metadata of this kind would

facilitate the development of technical pathways directly into explanatory content, content that is often sought from *why*-questioning – thereby supporting the goals and processes of knowledge management while also supporting teaching and learning through the support of critical and reflective process.

**Paper 5 – Cognitive Engagement and Questioning Online**

Mason, J. (2011). Cognitive Engagement and Questioning Online. In A. Mendez-Vilas (Ed.), *Education in a technological world: communicating current and emerging research and technological effor*ts (90-99). Formatex. http://www.formatex.info/ict/book/90-99.pdf

This book chapter discusses a range of issues associated with supporting inquiry and deep reasoning while utilising information and communications technology (ICT). Debates concerning the deficits and affordances of ICT in terms of cognitive engagement serve as the initial point of focus. The role of questioning in critical thinking and reflection is considered in the context of scaffolding and new opportunities for ICT-enabled scaffolding identified. In particular, *why*-questioning is presented as an important consideration in the design of systems that not only require cognitive engagement but aim to nurture it (see pages 92, 96-97). Advances in automated question generation within intelligent tutoring systems are depicted as early innovations in this area with opportunities for both teaching and learning, where the machine, based on the query generates a series of well-formed questions that support the learner in probing specified content. While there exists evidence that shortening attention spans can be a product of engaging with digital media (Carr, 2010) cognitive engagement is presented as broader in scope than attention span and is advanced as a construct that draws on a rich mix of cognitive activities. A plausible explanation for diminished attention spans when engaging with digital media might be as a consequence of the volume of information and the speed at

which it can be accessed. However, while Carr (2010) notes the downside Prensky (2001) has advanced a counter view that "digital natives" engage in learning at "twitch speed" principally through gaming environments, equipping them with digital literacy skills which are also cognitively "malleable". Such debates will endure and it is not the place here to join them, apart from noting that another "plausible explanation" as to *why* diminished attention spans are associated with engagement with digital media is because mainstream interfaces and tools that support reflection and deeper inquiry are not yet mature enough to provide an environment where the *why dimension* can have visibility, even though it may be occurring at the group tacit level (Cook & Brown, 1999).

Within conceptions of inquiry-based learning, as represented by the Inquiry Project at University of Illinois (Casey & Bruce, 2011) and shown in *Figure 2.4,* questioning is shown to be fundamentally linked to learning.

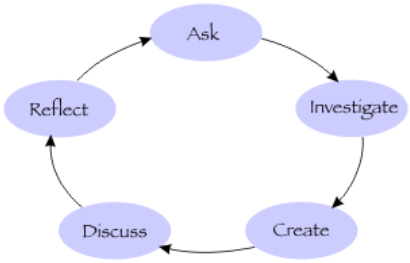


*Figure 2.4.* The inquiry cycle (Casey & Bruce, 2011)

This fundamental role of questioning within learning is also presented as a catalyst for cognitive engagement through in-session reflection and, therefore, as a pathway to deep learning.

The art of asking questions that help elicit the 'truth', reveal misconceptions and assumptions, or just the discovery of richer perspectives was most famously

developed by Socrates as a pedagogical technique nearly twenty five hundred years ago. Socratic questioning is therefore investigated for its viability in online contexts, because of the central position that questioning has within this approach to critical thinking and learning.

Linguistic perspectives are introduced in terms of classifying the various kinds of *why*-questions and the challenges associated with managing the semantics of *why* are outlined. This discussion (see pages 93-94) sets the context for an investigation of ICT scaffolding innovations that promote reflective inquiry, particularly within automated question generation techniques being developed within the intelligent tutoring community (Graesser, et al., 2008).

The paper concludes that innovation in technological development brings with it both challenges and enablers. With inquiry and reflection shown to be key elements of learning it is argued that appropriate support is required to nurture these activities. Such support needs to accommodate both the challenges and enablers of contemporary realities, in particular short attention spans; however, cognitive engagement supported by digital technology is shown to be much more than a question of attention span. If it is true for some that the rich information and one-click knowledge-sharing world is losing its balance through bloating and excessive interruption and search-and-distract behaviour then strategies need to be in place to re-balance it. Accommodating the *why dimension* in the "design of learning environments and in the conduct of teaching" is one such strategy (Mason, 2011, p. 98).

**Paper 6 – Scaffolding Reflective Inquiry: enabling *why*-questioning while e-learning**

Mason, J. (2012b). Scaffolding Reflective Inquiry – Enabling *Why*-Questioning while e-Learning. *Research and Practice in Technology Enhanced Learning 7*(3) pp.175-198. Asia-Pacific Society for Computers in Education. http://www.apsce.net/RPTEL/RPTEL2012NovIssue-Article3_pp175-198.pdf

There are two interrelated purposes of this paper: firstly, to provide some focused theoretical discussion on the importance of *why*-questioning as a means of supporting inquiry and reflection during learning; and secondly, to probe opportunities for ICT-based scaffolding that might support this.

The paper is framed by historical and theoretical perspectives that together inform the design and development of ICT tools that could support reflective inquiry during e-learning. Terminology is highlighted as important and *scaffolding* is clearly identified as an evolving concept that has come to mean the provision of support (through ICT as well as via teachers, peers and social networks) that assists in the maturation of understanding associated with learning activities.

The role of *why*-questioning in learning is guided by literature that spans critical thinking, inquiry-based and problem-based learning, storytelling, sense-making, and reflective practice. *Why*-questioning is profiled as a key component in a conceptualisation of scaffolding that promotes cognitive engagement.

The question of *'how might ICT be used to scaffold learning through supporting reflective inquiry and the probing of explanatory content?'* provides a key focus question for this paper. This raises issues of learning design and access to explanatory content and is discussed in terms of a distinction made between information and explanation, as in *Figure 2.5*. This distinction represents a core construct of this thesis by depicting specific functions associated with *why* questions

(in constructing or seeking a plausible explanation or a story). The term "journalist's questions" is adopted in *Figure 2.5* partly due to its common usage and also to give emphasis to the role of explanation and story (Urquhart & McIver, 2005, p. 82). Of course, these six questions do not belong to journalists and are widely used in many other domains of inquiry such as science and law.

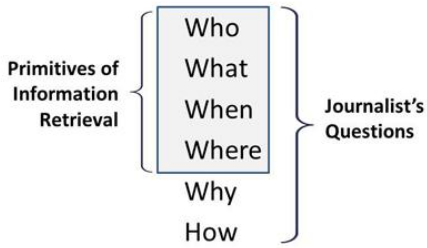


*Figure 2.5.* Core questions of information and explanation. (Mason, 2012b, p. 178)

It is shown (page 178) that the factoid nature of the primitives of information retrieval (*who, what, when,* and *where*) do not have the capacity to convey a story nor a plausible explanation without making use of other key primitive questions, *how* and *why*. As a consequence, it is argued that processing information or content that is managed and discovered by *who, what, when,* and *where* does not *directly* stimulate reasoning skills, such an important foundation to knowledge construction. This is not to say that reasoning does not occur in the processing of information but that the automated processing of information that enables information retrieval and discovery privileges these attributes of content (Mason, 2012a, p. 62). Following on from this, the development of *why*-questioning is also shown to be important to the development of critical thinking, reflective practice and integrated reflection (Barell, 2010, p. 175; Paul & Elder, 1999; Piaget, 1966; Wellman & Lagattuta, 2004).

The notion of *plausibility* of an explanation as being sufficient when learning also provides an important contribution to understanding the construction of knowledge, whether that knowledge is based upon true or false assumptions. Plausibility is conceived in terms that give emphasis to conceptual coherence and rational argument and is contrasted with factual (*who, what, where,* and *when*) or incontestable knowledge.

This paper also builds upon the discussion outlined within Paper 5 concerning linguistic perspectives associated with *why* and discusses contemporary findings from computational linguistics in the area of questioning-answering and natural language processing (Mason, 2011, p. 93; Verberne, 2010).

Evidence of how ICT scaffolding functions in contemporary systems suggests that wiki-based learning tasks, digital storytelling, and e-portfolio tools all demonstrate the value of accommodating reflective practice as well as the production of explanatory content in supporting reflective learning. While acknowledging such approaches to supporting reflective learning the paper identifies further scope for ICT tools that would directly support *why*-questioning.

The paper concludes by looking at the latent significance of older pedagogical models such as Bloom's (1956) taxonomy of educational objectives – in terms of both relevance and inadequacy to contemporary settings. While Bloom's hierarchical model has been questioned for its validity (Kunen, et al., 1981) and revised by others (Krathwohl, 2002) it can also be seen as having utility as a sense-making model (Mason, 2013-in press, p. 21). In Bloom's original framework six levels of learning are represented as a pyramid: knowledge, comprehension, application, analysis, synthesis, and evaluation – with the implication that each level of the pyramid

represents a higher order or learning. In this conception, however, *knowledge* is only really a facet of knowledge (i.e. *knowing-that* and based upon knowledge of factual content). Comprehension is defined at the next level (being able to describe and explain); it is pertinent here that *description* and *explanation* are conceived at the same level yet the digital infrastructure is overwhelmingly geared toward supporting descriptions of content, and by corollary, descriptive content. At all subsequent levels *knowing-why* is represented as for a requirement for expanding expansion of knowledge up the pyramid. In many ways, while Bloom's taxonomy could be revised to be more relevant to current circumstances it also represents a model that presents the fundamental components of integrated reflection. Moreover, it is a model that explicitly recognises *knowing-why*.

### Paper 7 – The *Why* Dimension, Dialogic Inquiry, and Technology Supported Learning

Mason, J. (2013 – in Press). The *Why* Dimension, Dialogic Inquiry, and Technology Supported Learning. In Sebastian Feller and Ilker Yengin (Eds.), *21st Century Education: Constructing meaning and building knowledge in technology supported learning environments*. Singapore: John Benjamins.

This paper (to be a chapter in a book) completes the suite of included papers by bringing together all the core constructs of this thesis. In doing so it also shifts emphasis upon *why-questioning* to the *why dimension*, a more complete construct in that it acknowledges activities other than questioning – learning, understanding, knowing, and explaining – while also making explicit the role of reasoning across both reflective and dialogic inquiry (as represented as the *Why Dimension of Inquiry* in *Figure 2.6*). While the *why dimension* has been introduced and discussed in earlier papers it is in framing this paper around *dialogic learning* that a more complete presentation is made. Central to this theoretical discussion are epistemological

constructs such as *becoming to know* (Jakubik 2011) and *sense-making* (Dervin 1998; Weick 1995; Snowden 2002). Supporting this theoretical discussion is a number of sense-making models representing the relationships between learning and knowledge and the characteristics of *why*-questioning. Reasoning, reflection, and dialogue are all identified as embedded within dialogic inquiry and these activities provide the context for consideration of how the *why-dimension* in technology supported learning environments may be supported.

Following Wells (1999; 2000) this paper focuses on *dialogic* inquiry which places emphasis upon the role of language in meaning-making and thereby provides some balance to earlier papers that emphasise the *reflective* potential of *why*-questioning. Within a contemporary digital environment that is dominated by opportunities to interact or engage using social media this is an essential consideration for how the *why-dimension* can be supported through design that integrates dialogic potential.

Through placing emphasis upon *sense-making* within learning the paper presents a number of different models which are shown to be expressive for specific contexts. *Figure 2.6* is introduced to represent the *why dimension* across a continuum of reflective and dialogic activity. Within this model reasoning, reflection, and dialogue are all activities associated with dialogic inquiry and these activities provide the context for consideration of how the *why dimension* in technology supported learning environments may be supported.

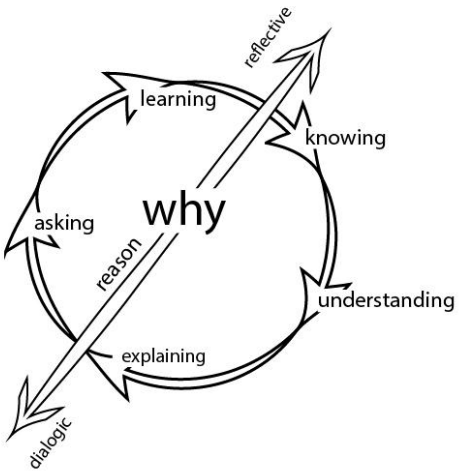


*Figure 2.6.* The *why dimension* of inquiry (Mason, 2013-in press, p. 23)

Abstract models such as *Figure 2.6* are presented as tools useful for sense-making; however, their utility is defined by context – and thus, sense-making shares with *plausibility* in explanations a function that assists in the construction of knowledge, knowledge that may be superseded by new knowledge. A number of other prominent models within the discourses of educational theory and knowledge management are used to illustrate this proposition (see pages 20-22). Just as there are limits to the expressive power of text, there are also limits to what abstract models can express; however, this expressiveness is of a different order and the multimedia-rich digital environment shifts the weighting from text as a prime source of documented discourse (and the reliance therefore upon rigorously defined conceptualisations and semantics) toward multiple channels of sense-making.

# Chapter 3: A Model for Sense-Making: Exploring *Why* in the Context of Learning and Knowing

**Citation**: Mason, J. (2008). A Model for Sense-Making: Exploring *Why* in the Context of Learning and Knowing. *The 16th International Conference on Computers in Education*, Taipei, Vol. 1, pp. 545-549.

http://www.apsce.net/ICCE2008/papers/ICCE2008-paper286.pdf

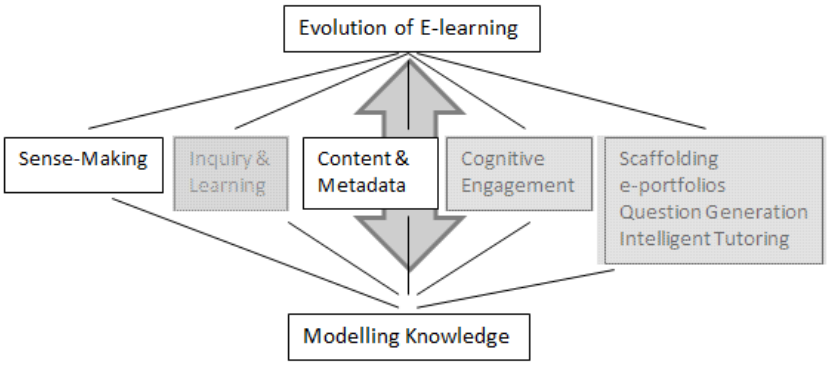


*Figure 3.1*. Topic Focus of Chapter 3.

*Figure 3.1* is used here as a partial representation of *Figure 1.4*, highlighting the key topics within this paper.

# A Model for Sense-Making: Exploring *Why* in the Context of Learning and Knowing

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**Abstract:** This paper outlines a working hypothesis that models the "problem space" spanning e-learning and knowledge management in simple terms. It does this by placing emphasis on the interrelationships between learning, knowing, and thinking within the context of a set of "primitive" questions: *Who*, *What*, *When*, *Where*, *How*, *Why*, and *If*. Particular attention is placed upon *Why* questions. By concentrating on these primitive questions it is anticipated that a certain degree of simplicity can be achieved in the model while not masking the richness and complexity that must be accommodated. It is proposed that such a model might inform the design and implementation of ICT systems that support e-learning and the creation and management of knowledge.

**Keywords:** e-learning, knowledge management, sense-making, metadata

## Introduction

This paper assumes and argues that the information and communication technology (ICT) infrastructure supporting e-learning and knowledge management (KM) has a high degree of commonality. This assertion is based on a common-sense proposition that thinking, learning, and knowing are all closely related [1]. It is an assumption that is validated by trends toward the modularization of digital content and computational processes within an increasingly networked environment [2,3]. The challenge, and the central topic of this paper, is in the development of a hypothesis and supporting model that adequately represents this in a way that may then be used to inform future ICT innovation that supports e-learning and knowledge management.

In setting the scene for an elaboration of the prototype model, discussion touches on the topics of networks, metadata, and knowledge management in order to provide background context and to explain *why* the model makes sense.

## 1. Scanning the Environment

### *1.1 Our Networked World – Linking Know-Who and Know-How*

Advances in ICT infrastructure development are as much about networks as they are about technological capability. As such, there is an increasing interconnectedness of entities (human, organizational, and technological) that can share and exchange data, information, and knowledge. Numerous protocols and conventions enable such exchanges and these play an important role in supporting learning, knowledge sharing, and networking.

Throughout history all kinds of innovation from secret Australian aboriginal song-lines and North American Indian smoke signals to Web 2.0 applications and the Semantic Web can be seen as supporting networks – networks that share knowledge. In recent decades, however, the depth and reach of networks can be seen as approaching a profoundly ubiquitous state [4, 5, 6, 7, 8, 9]. Historically, this represents the birth of a major era for civilization. [10] With the flows of information identified as key, as Castells suggests, it makes sense to consider the potential impact on the configuration of classrooms in traditional educational institutions and what optimum channels for learning might be.

For both learning and knowledge networking, then, connecting with others (peers, mentors, and experts as well as teachers and family) is an important activity in this environment. Doing so builds relationships that in turn enable new pathways of becoming or keeping informed. Importantly, networks bring together *know-who* and *know-how*.

### *1.2 The Role of Metadata – Who, What, When, Where*

In the Web context, *metadata* represents a typical example of a mechanism that enriches content and enables linking and re-use of *information* – metadata being defined here as data that either describes or identifies other data or information.

Enabling effective resource discovery and information retrieval are the prime functions of metadata, which in turn are essential for business efficiency and effective online learning, education and training. However, metadata can itself function as data and can convey recursive contextual information, introducing layers of complexity [11].

One approach to dealing with this complexity is through Semantic Web technologies such as the Resource Description Framework (RDF), where metadata statements can express information about *relationships* between entities as well as the entities themselves.

While there are a number of sophisticated software engines that enable effective resource discovery and information retrieval it is arguable that most metadata systems (including metadata that is imputed or assigned by algorithms) are biased toward processing descriptions, terms, keywords, or hyperlink weightings, and therefore have a limited capacity to parse semantics and infer sufficient context to handle anything other than simple queries relating to *Who, What, When,* and *Where*. In other words, the metadata that assists in discovery and retrieval is largely concerned with *aboutness*.

A core underpinning of the prototype model discussed below is that many metadata schemas can be distilled to a core set of "primitive" questions concerning the basics of information: *Who, What, When, Where?* [12]. When it comes to learning, and knowing other "primitives" are also key: *How, If, Which*, and *Why*. These questions pose considerable challenges for how metadata might best be specified and configured for learning. Of the latter four questions (*How, Which, Why,* and *If)* it is *Why* that provokes the widest response. It is a question that either demands a narrative response or it propagates further questions relating to context. It is the question that young children first ask as they start to make sense of the world. It is the question we all ask as we make sense of the world anew.

### *1.3 Knowledge Management*

Like e-learning, the knowledge management (KM) field has emerged within the last few decades. It is often understood as an organizational intervention in terms of management efficiencies but is also an evolving academic discourse characterised by much debate. [13,14,15,16,17]

The influence of networks and networking upon KM suggests that there is still plenty of scope for developing other models – models, for instance, that can not only represent the range of activities associated with managing knowledge but also the processes of knowing. This is borne out in a recent blog post by Sims (2008) in which an analysis of 53 knowledge management definitions is presented:

> "General observation: this again illustrates the definition diversity. It is not like these are 53 definitions with slightly different word choice. These are substantially different. There are only five attributes that are seen in 30% or more of the definitions: KM is a process, it is targeted at the organization (company), it deals with knowledge, sharing is part of the story, and the definition includes a "*why*"." [18]

It is noteworthy in the context of this paper that *Why* has some prominence as one of the attributes having commonality.

## 2. The Sense-Making Model


Figure I – The InterCog Sense-Making Model

### *2.1 Common Sense and Learning Theory*

Figure I models the working hypothesis and represents thinking, learning, and knowing in an interdependent relationship that is intended to convey movement or activity. These activities will typically converge into one activity or experience. Common sense, after all, is a filter that enables us to make sense of things easily. It is when theoretical elaboration is pursued that such simple propositions reveal enormous complexity. Thus, anyone who has studied to become a teacher will know there are numerous theories of learning [19,20,21].

### *2.2*

> "After all, what do we know now that we didn't know ten years ago? That learning and knowledge are the result of multiple, intertwining forces: content, context, and community". [22]

Seely Brown made this comment in 1998 but it still seems to hold true. This is why these three influences are represented in the outer ring of the model. Again, movement and interconnection are part of this representation.

### *2.3 Seven 'Primitives'*

Figure I has taken a number of years to develop and has been influenced largely by considering the challenges associated with defining metadata schemas that are not only adequate in networked environments but are sufficient when applied to processes of learning and knowing as well as resources that support these processes. Various iterations of this model have included more 'primitives' (fundamental questions) than the seven represented (e.g., *Will, Whether,* and *Which*); however, these latter questions appear to be of a second order to those that seem critical to sense-making.

The most significant conclusion concerning mainstream metadata schemas is that they are primarily designed to accommodate variations and extensions of *Who, What, When*, and *Where* information. Following this observation the working hypothesis of the InterCog Sense-Making Model (ISMM) is that these four fundamental questions are the primitives of information discovery. That is not to say that they do not support learning and knowing – they do! But what is characteristic about them is that they tend to be most applicable to the description of *resources*, as opposed to *processes*. Properties associated with these questions are also objective information.

The ISMM represents three other fundamental questions and the working hypothesis is that these three primarily represent the primitives of learning and knowing. They seem fundamental to making sense of the world and in the construction of knowledge about it.

*How* questions will typically yield answers that are procedural in nature. *If* questions generally trigger a following question (*If-Then, If-Will, If-What,* etc) and can be modeled in rule-based terms.

Arguably more significant than either *How* or *If* are *Why* questions. This is because while serving the important function of helping "make sense" of things, answers to such questions typically demand an explanatory narrative – a rationale. Unlike the more objective primitives of information discovery it is typically the case that a 'definitive' answer is not achievable but rather a range of explanations. It is also of interest that a *Why* question within a scientific discipline of study (e.g., *Why does salted water boil at a higher temperature than pure water?*) more readily provides an "answer" than do questions pertaining to political history (*Why are the Israelis and Palestinians at war?*).

## 3. Conclusions and Future Work

Over the last decade ICT applications developed to support learning and knowledge management have moved through a number of phases. In the majority of cases these applications have been developed to facilitate and/or manage access to *learning content* and to support and develop *communications* associated with learning and knowledge sharing. A smaller proportion of applications have been focused on supporting teaching and learning *activities* and *workflows* associated with knowledge sharing and management. Analysis suggests that despite the proliferation of applications there exists a broad frontier in terms of ICT innovation that might facilitate deep learning and holistic implementations of KM.

The InterCog Sense-Making Model has been presented to help distill and explain the relationships between networks, metadata, learning and knowledge management. These relationships must be understood in order to inform and underpin future development of ICT infrastructure and services relevant to e-learning and knowledge management.

A key objective for future work will be to test the working hypothesis associated with the "primitives" of learning and knowing and to determine whether analysis of "answers"

associated with *Why* questions might yield structures and patterns (in terms of secondary and tertiary pathways of investigation) as the most preferred or viable. If so, then it is anticipated that these findings might then inform the development of rich scaffolding to enable learners to probe deeper into a subject domain while engaging in e-learning.

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**Key Contributions of Paper 1**

This short paper makes a number of key contributions to this thesis:

Firstly, it provides some narrative context on the evolution of e-learning and positions both the topics of metadata and knowledge management as highly relevant within this evolving context.

Secondly, it establishes the utility of *Figure 2.1* as a faceted model of thinking, learning, and knowing – highlighting *why* as a *primitive question* that demands attention. It is suggested that such a model can inform future development of ICT infrastructure.

Thirdly, *Figure 2.1* is presented as a *sense-making* model, in which *why* is given emphasis as a necessary component of *sense-making* – thereby asserting the prominence of *sense-making* as a central construct of the thesis.

Fourth, it identifies *who, what, when,* and *where* information as the core components of metadata schemas and thus identifying *why* as having an explanatory function more than a descriptive one.

Finally, this paper exposes two assumptions of the researcher at the early stages of PhD candidature, namely, that likely future research would involve an analysis of "answers" to *why*-questions; and, that the key challenge in understanding the function of *why* in learning would be through understanding the semantics associated with it. As is shown in subsequent papers, however, it is further analysis of the dimensions of *why* that becomes the focus of inquiry.

# Chapter 4: Theorizing *Why* in e-Learning:

# A Frontier for Cognitive Engagement

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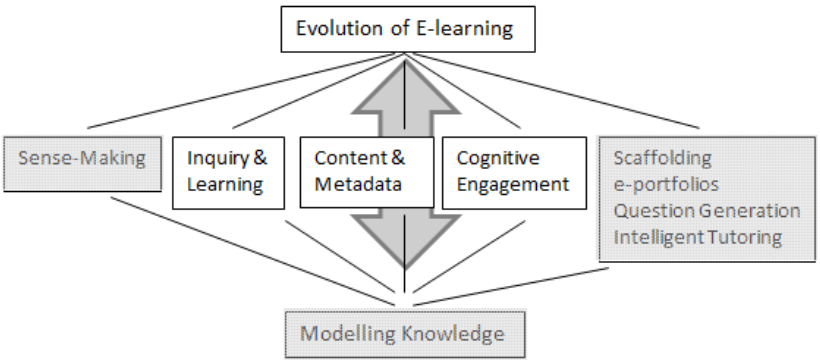


*Figure 4.1.* Topic focus of Chapter 4.

*Figure 4.1* is used here as a partial representation of *Figure 1.4,* highlighting the linkage between key topics within this paper.

# THEORIZING *WHY* IN E-LEARNING – A FRONTIER FOR COGNITIVE ENGAGEMENT

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**ABSTRACT**

*Asking why* is an important foundation of inquiry and fundamental to the development of reasoning skills and learning. Despite this, and despite the relentless and often disruptive nature of innovations in information and communications technology (ICT), sophisticated tools that directly support this basic act of learning appear to be undeveloped, not yet recognized, or in the very early stages of development. *Why is this so?* To this question, there is no single satisfactory answer; instead, numerous plausible explanations and related questions arise. After learning something, however, *explaining why* can be revealing of a person's understanding (or lack of it). What then differentiates *explanation* from *information;* and, *explanatory* from *descriptive* content? What ICT scaffolding might support inquiry instigated by *why*-questioning? What is the role of reflective practice in inquiry-based learning? These and other questions have emerged from this investigation and underscore that *why*-questions often propagate further questions and are a catalyst for cognitive engagement and dialogue. This paper reports on a multi-disciplinary, theoretical investigation that informs the broad discourse on e-learning and points to a specific frontier for design and development of e-learning tools. Probing *why* reveals that versatile and ambiguous semantics present the core challenge – asking, learning, knowing, understanding, and explaining *why*.

**KEYWORDS**

scaffolding, inquiry, *why*-questioning, reflection, understanding, cognitive engagement, cognition in education

## 1. INTRODUCTION

In introducing any topic of investigation it is usually helpful to understand *why* it is presented and *what* its key drivers are; a listener or reader often finds it helpful to understand the context of an investigation in order to make some initial sense prior to embarking on giving it further attention. Such context can also be described in terms of motivation, purpose, rationale, and/or justification for the work – or as "advance organizers" (Ausubel, 1960). Perspectives that emerge from responding to questions help to explicate some context – e.g., (i) *why is this paper submitted to CELDA 2012?* (ii) *what is the central argument of this paper?* Providing perspective of this kind can serve as a trigger for cognitive engagement and doing so – in the form of a well-constructed *abstract* – is an established academic convention. Roots of influence for this practice stretch back to the time of Aristotle, when *logos* was elaborated as well-formed argument within reason and, as such, one of three modes of persuasion – the others being *ethos* and *pathos*.

Thus, motivation for this paper emerges from consideration of future prospects for e-learning activities that probe the *why* dimension, or inquiry that involves *why* – asking, learning, understanding, knowing, reflecting upon, and explaining *why*. In order to develop an overarching narrative a number of interrelated topics are discussed: the evolution of e-learning; the role of questioning while learning; descriptive versus explanatory content; inquiry-based learning; scaffolding using information and communications technology (ICT); and, future prospects for ICT tools that support and promote *why*-questioning.

As a consequence of extensive academic literature on the subject it is assumed that *asking why* is an important foundation of inquiry and fundamental to the development of reasoning skills and learning. But, in direct contrast, sophisticated ICT tools that directly support this basic act of learning appear to be either undeveloped or, at best, in the very early stages of development. *Why is this so?* On the one hand, this paper

suggests there are a number of very good reasons; on the other, it is focused on the implications of developing better tools that support *asking why* and *understanding why* in the specific context of e-learning. It summarises relevant research with a view to informing the design of ICT tools that might stimulate deep learning and cognitive engagement. In supporting a clear rationale for the investigation the following real-world scenarios describe common, contemporary situations in e-learning involving concepts of *why*:

## 1.1 Scenario – University Student

Sarah is a university student majoring in international relations and history. She has opted to do much of her studies online because it provides her with the flexibility to take on some part-time work. The university has invested considerable funds into preparing appropriate content and assessment tasks for subjects offered in online mode; it has also implemented a standard single-platform policy and installed BlackBoard, a Learning Management System that helps structure learning content and contain interactions between staff and students. Sarah uses Google to search for additional resources for an essay on the conflict in the Middle East. While she finds numerous resources it is challenging for her to understand the causes of this conflict or what the appropriate actions might be for it to be resolved. The course resources seem well-structured but she is required to investigate sources beyond the prescribed texts. If she searches Google with '*why'* questions she feels very dissatisfied with the quality of the results. Likewise, when searching the library catalogue she is overwhelmed by the volume of resources and is not confident in making a judgement about *why* this conflict seems so deeply problematic because she finds so many plausible, yet contradictory, and politicized explanations. Even though she has access to a number of 'social software' applications that enable her to interact and share resources easily with others who might be investigating the same topic she feels like there is something lacking in the online tools available. She feels that she needs assistance in discerning fact from political rhetoric and some other way of navigating and evaluating the large amount of content on this topic. She wants to *understand* the key issues at the heart of the conflict.

## 1.2 Scenario – High School Teacher

Dave is an art teacher at a high school with two decades of experience. The school has a reputation for adopting ICT into the curriculum wherever possible; however, art has been the last subject to embrace ICT. This is partly due to the fact that Dave feels more comfortable using traditional media. The school is now urging him to make the shift. In moving his content into an electronic mode Dave discovers that he has to anticipate many of the questions that students typically ask when in the classroom ('*but why do we have to study Matisse, sir?*'; '*why is some abstract art seen as having great merit while some doesn't?*'; '*why are there different versions of what constitute primary colours?*'). Because of his experience he knows that the students need good answers to such questions so that they can be motivated to learn. He thinks that he may need to create a bank of such questions together with suitable answers but hesitates because he knows that when students ask questions a longer conversation often proceeds. He is unsure of the best way to make such information available so chooses just to make it explicit in the introductory text to each task described in the online version of his course. But he remains sceptical that anticipating such questions in a 'canned' way will be as motivating for the students as being able to respond in real-time. He would prefer to foreground student questioning and make it stimulating and interactive, rather than content that students read.

## 1.3 Scenario – Instructional Designer

Thor is an instructional designer for a publishing company that specialises in de-mystifying science. The publisher has already had commercial success in preparing online materials that mimic the successful television series in Australia during the 1960s, '*Why is it so?*' Thor has been asked to assist in developing innovative pathways to scientific content that will stimulate students to think and ask '*why'*, to motivate their curiosity and that leads them into understanding scientific inquiry. He is not quite sure how to proceed and is suspicious of Q&A approaches because providing answers can often close down inquisitiveness; he knows that powerful search engines like Google can deliver responses to search queries but will also limit the student to searching, not *questioning*; he also aware that none of the natural language search engines he knows of seem to do a very good job with responding to *why* questions. How is he to proceed?

## 1.4 Scenario – Teacher Librarian

Lisa is a teacher-librarian. She has access to a range of repositories of high quality, digital learning content. Most of this content is described using Dublin Core metadata (i.e., information such as the author, title, keywords, and abstract) and some of it is described by IEEE Learning Object Metadata (i.e., information similar to Dublin Core metadata but also includes information about the educational level associated with the content and duration of the resource). Some resources also have metadata that describes associated learning objectives and competence level required in order to interact effectively with the resource. Lisa has found that many of the teachers she supports also want to know *why* a particular resource might be more suitable than another for a particular learning activity or goal. Lisa has found that rating systems and user-generated tags and 'folksonomies' are sometimes helpful in this regard but is frustrated that not all the repositories support such services. She wonders whether there might be a better approach.

# 2. E-LEARNING EVOLVES

## 2.1 Terminology and Scope

Theory and practice of any domain of human activity are constantly evolving and mutually informing. But while both philosophers and practitioners have discussed matters associated with *learning* for thousands of years, it is not yet two decades since the term *'e-learning'* entered mainstream discourse. It is therefore important to make explicit what is meant by this term as it has been appropriated by diverse communities of practice since it first appeared around 1998-99 (Cross, 2004; CIPD, 2008; Garrison and Anderson, 2003).

*e-Learning* can signify both a theoretical discourse and a range of activities that take place in many contexts – formal and informal, within educational institutions and workplace settings, or elsewhere '*any time any place*' as the saying goes. Adopters of the term include corporate training associations, professional associations, academic Web enthusiasts, government policy makers, software vendors, standards development organizations, and military organizations, just to name a few (Mason, 2005:320). There are distinctions according to context. For example, Bates identifies key differences between post-secondary education and corporate settings – the latter being more concerned with the broader context of knowledge management, the former focused on learning and research (Bates, 2004: 275). In an attempt to broaden philosophical perspective, Friesen puts the case for "re-thinking e-learning research" and argues for a "reconceptualization of e-learning as an inter- and cross-disciplinary endeavor" (Friesen, 2009:20). Conceptualizing in even broader terms, Cooper argues that its scope of activity is best understood as '*emergent'* and therefore subject to analyses that highlight perspectives on "complexity" (Cooper, 2010). Others prefer to use the related terminology *'online learning'* to frame the challenges of "integrating technology into classroom instruction" (Tomei and Morris, 2011). For the purposes of this paper, *e-learning* is defined as: *learning that is facilitated by engagement with ICT*.

## 2.2 Innovation and Practice

With the above definition in mind, a diversity of ICT development and innovation over the last few decades can meaningfully be described as *e-learning* systems, environments, or platforms. Examples of *structured, contained,* or *purpose-built* platforms include computer-based training systems, learning management systems, intelligent tutoring systems, e-portfolio systems, performance support systems, virtual worlds, gaming environments, e-books, and other related applications and services. Anyone with a young child who has access to an iPad will also know how engaging and educational a single app can be – whether it is explicitly educational or not. Examples of *unstructured* and *open* environments that can function as e-learning environments include use of mainstream search engines and social media. Benefits and deficiencies can be identified with all of these developments, as is documented in the extensive and growing discourse on e-learning – for example, the number of peer-reviewed journals worldwide dedicated to the subject is now in excess of 50 titles and the majority of these titles have emerged in the last five years. If related topics such as

Distance Education, e-Research, Technology in Society, Knowledge Creation, and Performance Support are included then there are hundreds of relevant journals.

As e-learning develops into an established academic field it brings with it a discourse that refines its core concepts and terms while ICT innovations and trends evolve. It is also likely that certain trends and biases will be revealed along the way. For instance, evidence suggests that much of the first generation of practice associated with e-learning has been very focused on the delivery and access to *purpose-built learning content*, not so much with *learning activities* or the *cognitive processes* associated with learning (Dalziel, 2003; Alonso, *et al.*, 2005; LETSI, 2008; ADL, 2009). This first generation of learning content has also been constrained by metadata that is *descriptive* in function – in other words, metadata that describes the content in terms of semantics that have roots in *who*, *what*, *when*, and *where*.

It is also the case that the educational potential of existing, emerging and future developments in ICT is now commonly discussed in many diverse settings (daily newspapers, school curriculum support materials, political party policy documents, workplace human resource departments, standards-setting bodies, academic literature, and in higher education strategic planning). The *'Digital Education Revolution'* policy of the Australian Governments during 2007-2012 is a prominent example of a public policy response. Such public policy has been commonplace since the invention of the World Wide Web, although prior to this, the transformative potential of educational technology was recognised at various other historical moments (such as with the inventions of radio, television, personal computers, interactive and game-based digital media). There are therefore multiple perspectives that help explain the history and viable developmental paths of e-learning into the future. The Australian *School of the Air*, which began in 1951 and continues today in servicing the needs of remote communities in Australia, represents an example of an older communications technology that is still used effectively for educational purposes. This is significant because it suggests that the viability of a technology is not necessarily made redundant by new technologies.

## 2.3 Historical and Social Narratives

Broader historical perspective provides further context. Not only has evolution of the World Wide Web taken place within a short period of time accompanied by rapid innovation, it has been *transformative*, representing a global revolution in the production, distribution, and access to information and communications (Castells, 1996; Benkler, 2006; Gleick, 2011) and can be seen as having enormous impact upon teaching and learning.

A number of commentators have consequently introduced narratives on the evolution of the Web in terms of its impact upon learning. Taylor (2001), for instance, began visioning "fifth generation distance education" around 2001-2002 as an "intelligent flexible learning model" – it was student-centric in conception but impacted significantly the organizational structures and readiness for institutions concerned. In 2005, Siemens proposed a new learning theory called "connectivism", motivated principally by the impact of the proliferation of networked ICT applications and the limitations of dominant learning theories (behaviourism, cognitivism, and constructivism) to explain and support the scope of interactions a learner. The distinguishing characteristic of Siemens' theory is the prominent role of networks in creating connections between disparate learning sources and events (Siemens, 2005). Siemens' work resonates with the extensive sociological work of Castells (1996, 2001) in outlining the "rise of the network society" and in the work of Benkler on the social production of intellectual capital (Benkler, 2006).

More recently, there has been popular usage of the terminology 'Web 2.0' typically to describe networking capabilities that leverage social media providing individuals with enormous scope for publishing content and social interaction. Adoption of such terminology has also led to characterisations of "Learning 2.0" being learning that is facilitated by Web 2.0 social media applications (Brown and Adler, 2008) and related commentary about the "post-LMS era" (Mott, 2010). The utility of such characterisations is yet to be determined; however, in terms of the evolution of e-learning, they can be somewhat misleading because they mask, or do not always explicitly acknowledge, the capabilities that already existed in early phases of development – such as in Computer Based Training (CBT), Computer Assisted Learning (CAL), Computer Managed Learning (CML), Computer Mediated Communication (CMC), and Computer Supported Collaborative Learning (CSCL). The important observation here is that there are numerous technologies that have shaped what e-learning is today. Secondly, and most importantly for this investigation, none of the innovations mentioned hitherto have explicitly explored how *why*-questioning during learning might be explored, supported or scaffolded.

## 2.4 Into the Future

With the foundations of e-learning now well-established there is enormous scope for new developments that may enrich learning experiences through supporting deeper *inquiry* and cognitive engagement via environments that stimulate reflective practice and the development of *understanding* while learning online. A number of likely future trajectories can be discerned from the current context – for example, the broad uptake of social media provides stimulus for the use of diverse collaborative environments at scales unprecedented. Other developments will emerge as a consequence of ubiquitous broadband connectivity, innovations in natural language search technologies, access to open content, the proliferation of mobile technologies, work integrated learning programs, and intelligent tutoring systems. Will IT develop further as an "intelligent technology" or an "interruption technology" (Carr, 2010)? No doubt, unexpected innovations will also impact the evolutionary story.

This paper, however, is concerned with *one* of the frontiers that beckon further development – *ICT that supports deep learning instigated by questioning, reflective practice, and promotes cognitive engagement.*

# 3. COGNITIVE ENGAGEMENT

## 3.1 Ubiquitous Distraction?

There can be little doubt that the Internet has spawned a proliferation of ICT tools useful for learning. But the story of the impact of such relentless innovation is not an intrinsically positive one. It is also accompanied by a growing discourse arguing that extended use of the Internet can also have detrimental effects on cognition and behaviour (Clark, 2002; Bannister and Remenyi, 2009; Carr, 2010; Aguirre, 2011; Chalupa, 2011). Evidence shows there is definitely an impact upon *cognitive load* (Verhoeven, 2009; Kleinberg, 2011), a topic that instructional designers have been concerned with for decades (Sweller, 1994). For example, for reasons that being online can be very distracting with the effect of weakening cognitive focus, the term "interruption technology" has been a catch-phrase in contemporary popular commentary on the Internet:

> the single most mind-altering technology that has ever come into general use … when we go online, we enter an environment that promotes cursory reading, hurried and distracted thinking, and superficial learning … The Net's cacophony of stimuli short-circuits both conscious and unconscious thought, preventing our minds from thinking either deeply or creatively. (Carr, 2010)

Of course, similar commentary and research has existed for decades about extended exposure to television and virtual gaming environments. Thus, the discourse is not all negative – for example, research shows that while extended Internet use can cause some loss of short-term memory there is also a gain in that "The Internet has become a primary form of external or transactive memory, where information is stored collectively outside ourselves" (Sparrow, et al., 2011).

There is truth in both arguments – so in terms of the nature of cognitive engagement while learning online, evidence that drives this debate will be important for researchers to track.

## 3.2 The Search Paradigm

The enormous market success of the Google search engine can be seen as paradigm-shaping in the way that much learning online and scholarship is now initiated – via *search*. Its functionality has also delivered routine information retrieval and discovery into the mainstream. Of course, not all searches using Google are concerned with learning and most are better classified as *information-seeking* and Google's effectiveness has also impacted corporate workflows, the socialization of information (Brown and Duguid, 2000), Government-based services, and the expectations of citizens of the developed world. As Google (the company) has developed its own services, such as *Gmail* and *Google Docs* and *Drive*, the flagship search engine can be seen as the core piece of technical architecture – *search* being the key operator on, and organizing technology for, *content*. Again, however, Carr notes a downside:

> Google … shapes our relationship with the content that it serves up so efficiently and in such profusion. The intellectual technologies it has pioneered promote the speedy, superficial skimming of information

> and discourage any deep, prolonged engagement with a single argument, idea, or narrative. "Our goal," says Irene Au, "is to get users in and out really quickly. All our design decisions are based on that strategy." (Carr, 2010:156)

The immediate counterpoint to this argument is that innovations in ICT are far richer than the Google suite of services. But, there is a further issue with the 'Google paradigm' relevant here: its search engine is calibrated with a design bias that privileges the *aboutness* of content – in other words, it is focused on parsing *information* as *data*. Its internal indexes are all built on data that is *factual* and *measurable*; and searches are typically instigated by keywords and phrases, *not questions* constructed in natural language. Thus, interactions with Google can be seen as being constrained by "factoid" information (Verberne, 2010), or what Mason describes as the "primitives of information-retrieval" – facets of information that are readily associated with questions of *who, what, when,* and *where* (Mason, 2008). While Google uses sophisticated algorithms involving various weightings associated with "backlinks" this still functions as factoid information. Even with value-added services to Google search, such as ManagedQ, results to queries are organized into sets associated with people (*who*), things (*what*), and places (*where*). This underlying constraint has the effect of 'information begetting information' and interrupts prolonged inquiry or direct pathways into the discovery of content that is *explanatory* in nature (Mason, 2008; 2011a). This does not mean that explanatory content is not retrieved, just that it is not easily or directly discovered. In particular, queries that are conceived with '*why'* in mind are not parsed well by Google because of the semantic ambiguity and linguistic versatility of the term *why* (Evered, 2005; Verberne, 2010; Mason, 2008). This has significant repercussions for the design of ICT systems aimed at supporting learning.

## 3.3 Dimensions of *Why* –Related Research

*Why* distinguishes itself from other 'primitive' questions (*who, what, when, where,* and *how*), in that it often requires a plausible *explanation* or rationale as an adequate response – in other words, reasoning as well as information (Verberne, 2010:10). Thus, *why*-questioning has the potential to initiate a shift from information processing to engagement of other cognitive functions, such as inquiry, analysis, problem-solving, and reflection. As Walton has noted, *why* is a key initiator of dialogue (Walton, 2004).

For researchers pursuing question-generation techniques in intelligent tutoring, *why* questions are seen to belong to a "deep/complex" category of all possible question types (Graesser, et al., 2007). Evered (2005) provides an analysis in which the function of responses to *why*-questioning is categorized according to three classes of explanation: Causal (*Why E? Because C* (C = cause)); Teleological (*Why E? In order to P* (P = Purpose)); and Gestaltic (*Why E? For these reasons*, R (R = Reasons)) (Evered, 2005:201). Thus, in identifying opportunities for ICT-enabled scaffolding that might support inquiry and reflection, access to and production of *explanatory* content, as distinct from *descriptive* content, is of prime concern here.

It is also interesting, however, that while *why* can be shown to have wide linguistic versatility (Mason, 2011a:93) it is not regarded as a "semantic prime" by linguists developing Natural Semantic Metalanguage (research that is focused on identifying concepts with irreducible semantics), primarily *because* this versatility is not free from ambiguity (Goddard and Wierzbicka, 2007).

Thus, in probing the linguistic dimensions of *why*, at least five key activities relevant to e-learning can be identified – asking, learning, knowing, understanding, and explaining *why*. The literature on educational psychology tells us that *asking why* is an important foundation of inquiry and fundamental to the development of reasoning skills and learning (Dewey, 1966; Piaget, 1966; Schank and Cleary, 1995; Bruce and Casey, 2012). Processes of *learning, knowing,* and *understanding why* build upon inquiry and all involve reflective practice (Schön, 1987:72). After learning something, *explaining why* can reveal a person's understanding (or lack of it). Thus the motivating question for this investigation: what ICT scaffolding – as application, services, or interventions – might support inquiry instigated by *why*-questioning?

## 3.4 Tools for Scaffolding and Reflective Practice

Investigations into ICT tools that explicitly aim to support *why*-questioning reveals a number of search technologies based upon natural language processing and computational linguistics, although findings to date demonstrate that much research is yet to be done (Ferrucci, et al., 2010; Verberne, 2010). Research is also proceeding in the fields of information science (metadata schemas and question-answer techniques) and

question-generation for intelligent tutoring (Kunze, 2001; Mason, 2008; Rus and Graesser, 2008). Of immediate relevance, however, is the application of wikis and e-portfolio systems to support reflective practice that is consistent with the goals of inquiry-based learning. Evidence is mounting that both approaches – one via the route of enlisting open, social engagement in content production (wikis); the other, individually-controlled reflective journalism that is discretionally shared – develop reflective practice and therefore prolonged cognitive engagement (Loo, 2012; Mason 2011b). A challenge, then, that is specific to the focus of this investigation is how scaffolding interventions might leverage these platforms.

## 4. CONCLUSION

Investigations into *why*-questioning reveal there are significant repercussions for the design, development, and utilization of ICT systems aimed at supporting learning. In particular, accommodating multiple dimensions of *why* – asking, learning, knowing, understanding, and explaining – point to a frontier that will focus on the pivotal role of *explanatory* content and prolonged cognitive engagement through reflective practice.

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**Key Contributions of Paper 2**

This conference paper makes the following contributions to this thesis:

Firstly, it makes use of narratives that describe scenarios to elaborate upon the diversity of contexts in which the *why dimension* is exposed as needing support from digital technologies.

Secondly, while not yet explicitly identifying the *why dimension* as an emergent construct it introduces the *dimensions of why* as a means of indicating scope of an emerging theoretical framework. These dimensions are identified as five activities: *asking, learning, understanding, knowing,* and *explaining why.* In doing so it shifts the focus on questioning established in Paper 1.

Thirdly, this paper introduces the search paradigm as a construct and defined as "the key operator on, and organizing technology, for content" (Mason, 2012, p. 61).

Finally, it positions the challenge of technological development that might support the *dimensions of why* within an evolving historical context.

**NOTE:** An extended version of this paper, which includes additional scenarios and further contextualized by narratives on openness in education in which *openness* is also shown to be an evolving construct, has since been developed as a book chapter, reviewed, and in the process of being published (see citation below).

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# Chapter 5: Opening Digital Learning to Deeper Inquiry

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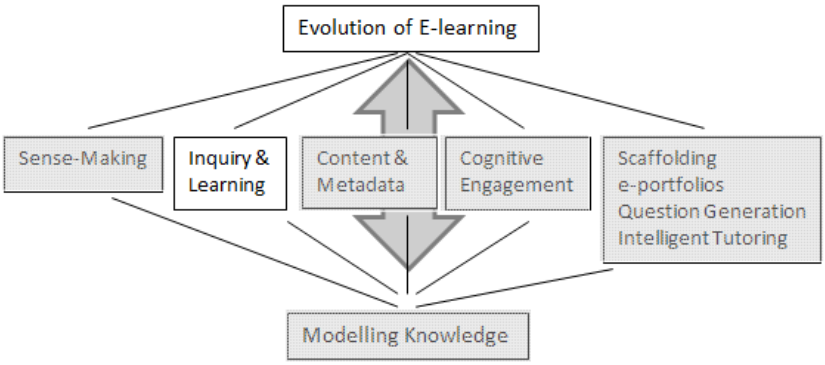


*Figure 5.1.* Topic focus of Chapter 5.

*Figure 5.1* is used here as a partial representation of *Figure 1.4*, highlighting the linkage between key topics within this paper – inquiry and learning in the context of the evolution of e-learning.

# Opening Digital Learning to Deeper Inquiry

Jon Mason & Hitendra Pillay

## Abstract

This chapter presents an historical narrative on the recent evolution of information and communications technology (ICT) that has been, and is, utilized for purposes of learning. In other words, it presents an account of the development of e-learning supported through the Web and other similar virtual environments. It does not attempt to present a definitive account; as such an exercise is fraught with assumptions, contextual bias, and probable conjecture. The concern here is more with contextualizing the role of inquiry in learning and the evolving digital tools that enable interfaces that promote and support it. In tracking this evolution, both multi-disciplinary and trans-disciplinary research has been pursued. Key historical developments are identified as well as interpretations of the key drivers of e-learning over time and into what might be better described as digital learning. Innovations in the development of digital tools are described as dynamic and emergent, evolving as a consequence of multiple, sometimes hidden drivers of change. But conflating advancements in learning technologies with e-learning seems to be pervasive. As is the push for the "open" agenda – a growing number of initiatives and movements dominated by themes associated with access, intellectual property, public benefit, sharing and technical interoperability. Openness is also explored in this chapter, however, more in terms of what it means when associated with inquiry. By investigating opportunities for the stimulation and support of questioning online – in particular, *why*-questioning – this chapter is focused on "opening" content – not just for access but for inquiry and deeper learning.

## Introduction

Advancements in learning technologies are being driven from an increasing diversity of domains of practice and research. Through identifying the evolution of e-learning and its transformation to digital learning from various historical standpoints this chapter highlights that contemporary development within the field of e-learning points to opportunities for technological innovation and practical implementation of e-learning that provides support and scaffolding for inquiry. Discussion is first focused on the issue of terminology and the broad semantics associated with *e-learning*. The fact that this term has been widely adopted and defined in diverse ways, however, is not necessarily an academic problem to be solved – certainly not here. One of the themes this chapter is concerned with is the broad range of semantics associated with the word *open*. In the latest edition of the Australian Macquarie Dictionary, for example, there are well over eighty different meanings listed. Such breadth also brings high utility.

Historical perspectives on the evolution of the theory and practice of e-learning are also presented to show that this field can be accurately described as *emergent*. Because of the scale of development and diversity of inputs there is not one history of e-learning. History is always a combination of facts and interpretations contextualized by time and changing circumstances. For example, when the Web was first invented there was an abundance of literature that emphasized the revolutionary nature of hypertext and hypermedia (Landow, 1991). Yet in the contemporary setting the discourse has moved on and hypertext is rarely mentioned – whether it is highlighting the revolutionary nature of digital technology itself (as in the Australian Government's *Digital*

*Education Revolution* policy launched in 2008) or a particular facet, as in the literature associated with mobile learning where *mobility* refers to the learner, the technology, and the learning itself (Oller, 2012; El-Hussein & Cronje, 2010; Sharples, Taylor, & Vavoula, 2005).

The theme of openness in education is given emphasis in this chapter for the reason that it provides an informative case-study on the social response to the evolving digital infrastructure that supports learning. Opportunities for the "open agenda" to move forward into new territory are identified and by corollary therefore also point to opportunities for digital technology to likewise develop (Leeson & Mason, 2007). Of course, while *openness* is valued highly in the education sector, it is not the only driver of change or innovation with ICT that matters (see Figure 1). Social media continues to shape the nature of much engagement online and the late 20th century mantra that "content is king" is giving way to a fresh focus on so-called "21st century skills" where content is co-constructed by users and is often transient, and competencies such as digital literacy, critical thinking and problem solving are seen as more important (Griffin, McGaw, & Care, 2012). Oller (2012) argues that the big shift in e-learning theory and practice is currently being driven by mobile technologies, where the so-called "natural user interface" (NUI) enabled by handheld devices is surpassing the "windows-icon-mouse-pointer" (WIMP) paradigm of the personal computer era. Meanwhile, discourses on sense-making and developments in knowledge management and knowledge-sharing infrastructures continue to inform the theory and practice of e-learning (see for example, papers published in *Knowledge Management and e-Learning – an International Journal*). While acknowledging all these trends as significant the open agenda is highlighted for two other reasons:

1. It is an agenda that is deeply embedded within the history of the Internet and Web and can be seen to reflect this broader development in its own historical progression; and,

2. It provides suitable context for a frontier ready for further technological innovation: the stimulation and support of questioning online through *open* inquiry-based learning.

Within this setting, research into *why*-questioning is then highlighted to emphasize that, despite all the technologies and tools already available, a frontier for tool development focused on inquiry-based learning is yet to be adequately explored. This is the case largely because *why*-questioning, while so important during inquiry, presents numerous technical challenges for digital tool development. Why? Because the semantics involved typically involve ambiguity, dialogue, or further inquiry. Investigation into *why*-questioning reveals that the object it seeks is typically *explanatory content*. Such content is not straightforward to discover through conventional search engines because they are calibrated to retrieve information based upon factual data and sequential logic. While content that can be characterized as such thus presents challenges for learning technology design it also presents opportunities for innovative technology to support and stimulate reasoning skills and deep inquiry.

## E-Learning and Digital Learning

A review of the literature associated with digital learning shows it to be inextricably linked to *e-learning,* a term which reveals a wide domain of usage and conception. It is therefore important to make explicit what is meant by this term as it has been appropriated by diverse communities of practice since it first appeared in mainstream discourse around 1998-99 (Cross, 2004; CIPD, 2008; Garrison & Anderson, 2003). *Digital learning* is a more recent term and arguably has broader long-

term utility in that it comfortably describes learning via all kinds of technology devices that are built primarily for other purposes – such as games for entertainment or navigation through GPS.

Without embracing the term *digital learning* recent research aimed at developing an "inclusive definition of e-learning" and conceptual framework that supports it (Sangrà, *et al.,* 2012) identifies four broad categories of definitions: technology-driven, delivery-system-oriented, communication-oriented, and educational-paradigm oriented. This research was itself based on literature dating from 2005 and supplemented by a Delphi survey of international experts. This time constraint is perhaps limiting, however, because it is arguable that in the period 2002-2005 a number of other definitions already had high acceptance among practitioners and policy makers – for example:

1. For the OECD e-learning refers to "the use of information and communications technology (ICT) to enhance and/or support learning in tertiary education" (OECD, 2005, p.11).

2. For the UK Department for Education Services "If someone is learning in a way that uses information and communications technologies (ICT), they are using e-learning" (DfES, 2003).

But we are now well into the second decade of the 21st century and it is clear that *e-Learning* is a term that may be subsumed into *digital learning* – this is further highlighted by the appearance of a fairly awkward term, *mobile learning*, that is essentially e-learning through mobile (typically handheld) devices. However, there is a significant body of literature devoted to *e-learning* and this term can signify both a theoretical discourse and a range of activities that take place in many contexts – formal and informal, within educational institutions and workplace settings, or elsewhere '*any time any place*' as the saying goes. Adopters of the term include corporate training associations, professional associations, academic Web enthusiasts, government policy makers, software vendors, standards development organizations, and military organizations, just to name a few (Mason, 2005, p.320). There are distinctions according to context. For example, Bates (2004, p. 275) identifies key differences between post-secondary education and corporate settings – the latter being more concerned with the broader context of knowledge management, the former focused on learning and research. In an attempt to broaden philosophical perspective, Friesen (2009, p. 20) puts the case for "re-thinking e-learning research" and argues for a "reconceptualization of e-learning as an inter- and cross-disciplinary endeavor". Conceptualizing in even broader terms, Cooper (2010) argues that its scope of activity is best understood as '*emergent'* and therefore subject to analyses that highlight perspectives on "complexity". Others prefer to use the related terminology *'online learning'* to frame the challenges of "integrating technology into classroom instruction" (Tomei & Morris, 2011). For the purposes of this chapter, however, *e-learning* is considered as being transformed to *digital learning* and defined as: *learning that is facilitated by engagement with ICT*. Figure 1 summarizes some of the historical inputs that have shaped this evolution.

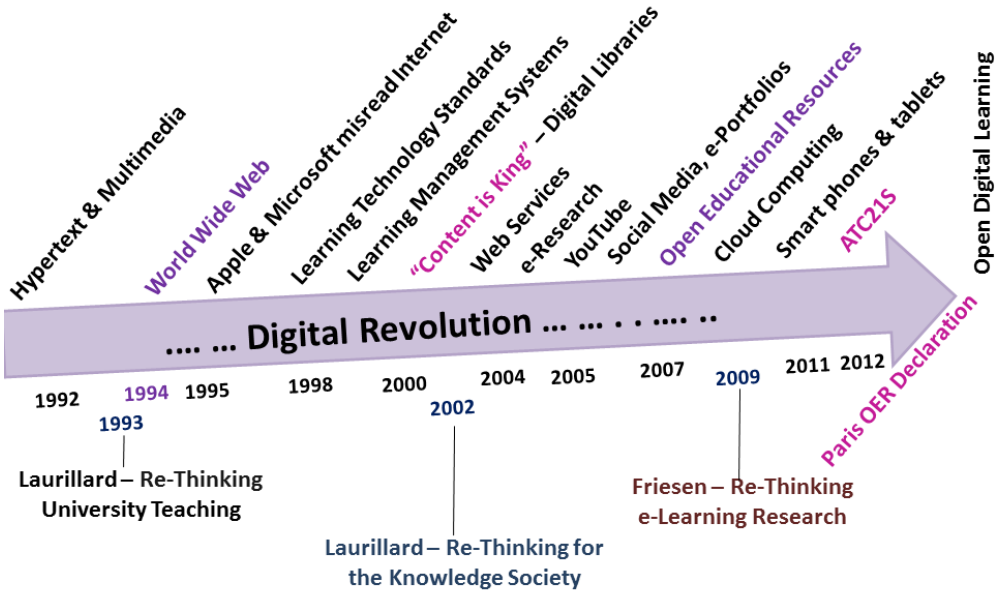


*Figure 1:* A Snapshot of Digital Learning Inputs

In tracking the evolution of e-learning as it progresses to open digital learning, both multi-disciplinary and "transdisciplinary" research is required because the perspectives required typically involve what has been termed "Mode 2 knowledge production" (Manathunga, Lant, & Mellick, 2006, p.365). This approach is necessary in order to span the relevant inputs enabling digital learning as well as to identify opportunities for future development. It is also arguably the case that the conceptual boundaries that define e-learning as an academic discipline are also emergent (Cooper, 2010) – as the term can describe both formal and informal learning enabled by ICT, and the ubiquitous nature of learning seems to blur the traditional conceptual boundaries thus creating confusion among digital learning practitioners. The following discussion on key historical developments is therefore intended to highlight the key drivers of digital learning over time.

## Historical Perspectives

A recognition that the educational potential of existing, emerging and future developments in digital technologies is applicable beyond formal schooling is now commonly discussed in many diverse settings (daily newspapers, school curriculum support materials, political party policy documents, workplace human resource departments, standards-setting bodies, academic literature, and in higher education strategic planning). This has come about largely since the invention of the World Wide Web, although prior to this the potential of educational technology was recognized at various other historical moments (such as with the inventions of radio, television, personal computers, and digital media). Not only has evolution of the World Wide Web taken place within a short period of time accompanied by rapid innovation it has been transformative, representing a global revolution in the production, distribution, and access to information and communications (Benkler, 2006; Castells, 1996, 2001). For instance, the shift from analogue TV to digital is transforming that tool as a complex and multilayered educational tool.

A number of commentators have consequently attempted to classify the evolution of the World Wide Web in terms of its impact upon learning. Taylor (2001), for instance, began visioning "fifth generation distance education" around 2001-2002 as an "intelligent flexible learning model" – it was student-centric in conception but impacted significantly the organizational structures and readiness for institutions concerned. In 2005, Siemens proposed a new learning theory called "connectivism", motivated principally by the impact of the proliferation of networked ICT applications and the limitations of dominant learning theories (behaviorism, cognitivism, and constructivism) to explain and support the scope of interactions of a learner and the nature of distributed, networked knowledge.

A distinguishing characteristic of Siemens' theory is the prominent role of networks in creating connections between disparate learning sources and entities. Because there exist important antecedents to this theory – such as connectionism within the field of artificial intelligence (McClelland & Rumelhart, 1986); actor-network theory (Latour, 1987); the sociological analysis of Castells (1996); and even the foresight of Bush (1945) – there is plenty of debate as to whether connectivism actually represents a new learning theory (Kop & Hill, 2008). Nonetheless, it is certainly the case that its articulation has gained significant worldwide attention and contributes to the understanding of digital learning.

It is worthwhile adding here that while the term *e-learning* may not have been coined until 1998 that learning with much of the educational technologies in the decade up until then could likewise be characterized as e-learning. It is therefore important to acknowledge that neither e-learning nor digital learning began when these terms were introduced. The capabilities that already existed in early phases of development were just described by different terms that each gave emphasis to a particular approach – for example, Computer Based Training (CBT), Computer Assisted Learning (CAL), Computer Managed Learning (CML), Computer Managed Instruction (CMI), Interactive Multimedia (IMM), Computer Mediated Communication (CMC), and Computer Supported Collaborative Learning (CSCL). It is also interesting that CSCL is a term that still has widespread usage while many of the others have fallen by the wayside.

Broadening historical perspective by looking into the roots of *open* movements provides further context for how digital learning may develop into the future with "the emergence of new kinds of open participatory learning ecosystems" (Seely Brown & Adler, 2008, p.32; Conole, 2013).

## Open agendas

For at least a century terminology associated with "openness" has been used in educational and social contexts (see Table 1 for a summary). An analysis of this usage, particularly since the beginnings of the Internet, reveal that the semantics are dominated by themes associated with *access, intellectual property, benefit to the public domain, sharing,* and *technical interoperability*. Each of these five themes has been important in shaping the Internet and World Wide Web. But what is most interesting about each of these themes is that none directly touch upon the semantics associated with "open learning", a term with roots attributed to Montessori (1967), Dewey (1910), and Piaget (1966) in which "openness" was used to describe a pedagogical approach that facilitates independent, inquiry-based and self-determined learning or "productive inquiry" (Brügelmann, 1975; Piaget, 1966; Lillard, 2005; Seely Brown & Adler, 2008, p.24). The summary information in

Table 1 therefore provides further context to the historical snapshot depicting the evolution of digital learning in Figure 1.

Table 1: Openness, Society and Learning

| Term | Associated Meaning | Origins |
|---|---|---|
| Open Learning | Independent, inquiry-based, and self-determined learning | John Dewey (1910)<br>Maria Montessori (circa 1911) |
| Open Society | Democratic governance, transparent government, and respect for human rights | Henri Bergson (1932) & Karl Popper (1945)<br>Advocated by George Soros with formation of Open Society Institute (1993) |
| Open Architecture | Extensible infrastructure (of the Internet) | 1969 (ARPANET)<br>International Organization for Standardization (ISO) Open Systems Interconnection (OSI) Model (ISO/IEC 7498-1:1994) |
| Open University | No academic prerequisites to entry; use of ICT including radio and broadcast television for distance learning and e-learning | 1971 (UK Open University) |
| Open Standard | Indicates that the process of development is transparent; the standard promotes *interoperability*; is publicly available; but intellectual property may be preserved | Mid 1980s |
| Open License | Typically non-commercial access to content and/or software | Richard Stallman and the GNU Project (1983)<br>Developed by Creative Commons (2001) |
| Open Source | Shared *intellectual input* into the development of software with specific but royalty-free licensing requirements | The term appeared in 1998 but roots of sharing software code date back to the beginnings of the Internet |
| Open Knowledge Initiative (OKI) | Interoperability specifications | Massachusetts Institute of Technology (2001) (Thorne et al., 2002) |
| Open Courseware (OCW) | Free access to structured, quality courses and content | Massachusetts Institute of Technology (2002) |
| Open Access | Royalty-free publication and dissemination of content (typically academic research) | The Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (2003)<br>arXiv.org influential (1999) |
| Open Content | Content that can be freely used and modified by others | David Wiley (1998) |
| Open Scholarship | Sharing intellectual endeavor and outputs | Can be traced to origins of arXiv.org with repository initiatives such as the Los Alamos National Laboratory |
| Open Educational Resources (OER) | Educational resources (content, digital tools, and standards) developed for free public access and use. | The term OER emerged in 2005 but content developed specifically for the public good or the "public commons" has been happening for centuries |
| Open Government | Using contemporary digital technologies to interact with very accessible Government departments | Emerged in wake of Web 2.0 as Government 2.0 but also arguably has origins in Open Society movement |
| Open Teaching | Being explicit and transparent about teaching methodologies | Diana Laurillard (2008) |
| Massive Online Open Courses (MOOCs) | Online learning involving large numbers of participants. | 2008. George Siemens and Stephen Downes deliver online course called "Connectivism and Connective Knowledge" |
| Open Data | Linked closely with Open Government; key drivers are public benefit and public ownership of publicly-funded data collection | 2010. Can also be linked back to the Open Archives Initiative (2000) and the protocol for exposing metadata records for reuse |
| Open Digital Learning | Digital Learning that combines meanings associated with OER together with emergent dimensions, such as inquiry, assessment, participation, and dialogue | Emerging now<br>Builds on OER with "new kinds of open participatory learning ecosystems" (Seely Brown & Adler, 2008) |

By conceiving of *inquiry-based learning* in terms of *openness* then a number of questions arise:

- *What does this look like when facilitated by digital technology?*
- *Do the digital tools currently available adequately scaffold open inquiry?*
- *What is the scope for development of digital tools that will promote open inquiry?*

Answers to these questions are pointed to in the following sections focused on questioning online and the role of *why*-questioning in particular.

## Questioning Online

Questioning is a fundamental activity of learning yet the digital tools that might promote it in self-directed, online learning contexts are quite limited – if interactive dialogue made possible by social media is excluded. This limitation is most readily seen in search and query technologies, which are typically calibrated to parse coded information and data created from factual information reducible to semantics that Mason has described as the "primitives of information discovery: *who, what, when,* and *where*" (Mason, 2008). There are of course other primitive questions such as *how* and *if* but from an information science perspective they can be seen to be concerned with procedural or rule-based information. Another way of describing this limitation of the inquiry tools currently available is that they lack sophisticated inference engines that can handle the ambiguities of natural language and, in particular, the ambiguities and functions of *why*-questioning (Verberne, 2010).

While learning can clearly take place without questioning – for example, through basic information-seeking, repetition and memorization – it is through questioning that high level cognitive functions such as inquiry, reflection, dialogue, reasoning, analysis, and knowledge construction take place. Thus, Glaser (1984, p.93) observed that "establishing a cognitive basis for a pedagogy that fosters thinking and reasoning in school learning has been continuously expressed by educators and researchers at least since John Dewey." Consistent with this perspective, socio-cultural philosophers of education, Freire and Faundez, have argued for the need for a "pedagogy of asking questions" that gives emphasis to questioning as something valuable in itself, where an answer may not even be relevant: "Thinking about questions that may not always or immediately arrive to an answer are the roots of change" (Freire & Faundez, 1989, p.37). More recently, Rothstein and Santana (2011) have developed this view in advocating the use of the *Question Formulation Technique* as a means to encourage students to ask their own questions) while Thomas and Seely Brown identify the emergence of a "new culture of learning" as a consequence of relentless innovation with ICT:

> We propose reversing the order of things. What if, for example, questions were more important than answers? What if the key to learning were not the application of techniques but their invention? What if students were asking questions about things that really mattered to them? (Thomas & Seely Brown, 2011, p.81)

To simplify the argument and to connect it to the underlying theme of this chapter, a metaphor can be made by describing the difference between *closed* questions (that seek yes/no or fact-based responses) and *open* questions (that seek to probe deeper, stimulate dialogue, and promote curiosity). *But what are the digital tools that promote open questioning?* Apart from research and

development into natural language search technology which is primarily concerned with automated question answering the most effective current tools are social or collaborative in nature, such as wikis, online forums and MOOCs (Butin, 2012).

## *Why* Questions as a key

To bring a sharper focus to the challenge of opening digital learning to deeper inquiry the development of tools that specifically scaffold *why*-questioning looks to be a promising frontier that warrants further investigation (Verberne, 2010; Mason, 2012). There are compelling reasons for this – reasons that are best reviewed in aggregate:

1. Technologies that support *information-seeking* are ubiquitous and available at the fingertips of anyone with a smartphone or other mobile technology – but they are not sufficient for scaffolding deeper inquiry.

2. Information-seeking is typically *a first step to inquiry* and a key activity of learning. Importantly, information-seeking only seeks a clear or factual answer to a search query.

3. In direct contrast to the primitive questions of information discovery – *who, what, when,* and *where* – *why* is a term that has ambiguous semantics. As such, it presents problems for data mining tools and search engines.

4. Inquiry instigated by *why*-questioning typically seeks a plausible *explanation, a rationale,* or *elaboration* as a response, not just information. As such, it is instrumental in stimulating or continuing a dialogue or interaction with other humans or devices. Importantly, *why*-questioning does not necessarily seek factual answers.

5. To *ask* why is to make sense of something. Thus, sense-making tools (textual and visual) may prove to be more effective than the dominant search paradigm of information-seeking when adequate responses to *why*-questioning are sought.

6. To *learn* why involves processes of reasoning, meaning-making, acquisition of knowledge, and the development of understanding. Thus, tools that directly support these processes would be useful for digital learning.

7. To *explain* why can invoke reasoning, storytelling, and reflection upon motivation, purpose and context – all activities so important to metacognition and deeper learning. *Explaining why* can demonstrate understanding or lack of it. Thus, tools that support the development of explanatory techniques would be useful for digital learning.

## Conclusion

The chapter presented the evolution of *e-learning* which is currently at a phase where it may be subsumed into *digital learning,* a term that has emerged as a means of describing a broader, more inclusive, set of digital technologies and contexts for learning – and perhaps not so fraught with debates about definition. The short history presented here can be seen in terms of changes in key technologies and theories over two decades; however, digging deeper into history also reveals the importance of the influence of open movements and suggests that more dimensions of openness –

beyond *access, intellectual property, public benefit, sharing* and *technical interoperability* – may also shape future innovations in digital technology. One such dimension looks as though it may involve digital tools that will directly scaffold and support prolonged and productive inquiry, and particularly inquiry that is instigated by questions of *why* and support the 21st century digital demands of productive citizens.

## Glossary of Terms

| | |
|---|---|
| ARPANET | Advanced Research Projects Agency Network |
| ATC21S | Assessment and Teaching of 21st Century Skills |
| CAL | Computer Assisted Learning |
| CBT | Computer Based Training |
| CMC | Computer Medicated Communication |
| CML | Computer Managed Learning |
| CSCL | Computer Supported Collaborative Learning |
| GNU | GNU is Not UNIX (a recursive loop) |
| ICT | Information and Communications Technology |
| MOOC | Massive Open Online Course |
| NUI | Natural User Interface |
| OCW | Open Courseware |
| OECD | Organization for Economic Cooperation and Development |
| OER | Open Educational Resources |
| OKI | Open Knowledge Initiative |
| WIMP | Windows-Icon-Mouse-Pointer |

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***Suggested index terms**:* digital learning, open, openness, open agenda, inquiry, inquiry-based learning, questioning, why, why-questions

**Key Contributions of Paper 3**

This book chapter makes the following contributions to this thesis:

Firstly, it combines two key narratives associated with the evolution of digital technology: the evolution of e-learning (and now more accurately *digital learning*) and the development of various 'open' initiatives summarised by the *open agenda*.

Secondly, by highlighting the origins of the construct *open learning* and associating it with more recent applications of openness in educational contexts such as *open access, open source, open licenses, open content,* and *open educational resources*, this paper points to the possibility of a broadening *open agenda* that embraces emergent expressions of openness: such as inquiry, assessment, and participation.

Thirdly, questioning online is discussed in terms of a frontier not yet fully explored given the prominent role that questioning has during inquiry.

Fourth, information-seeking is identified as "a first step to inquiry … [given that it] only seeks a clear and factual answer to a search query". In contrast, *why*-questioning is shown to involve complex semantics while also associated with deeper inquiry and reasoning.

Fifth, *why*-questioning is identified as a key challenge to "opening digital learning" that warrants further research and development of digital tools that specifically support it.

Finally, it elucidates upon three key aspects of the *why dimension: asking, learning,* and *explaining why*.

# Chapter 6: Knowledge Management and Dublin Core

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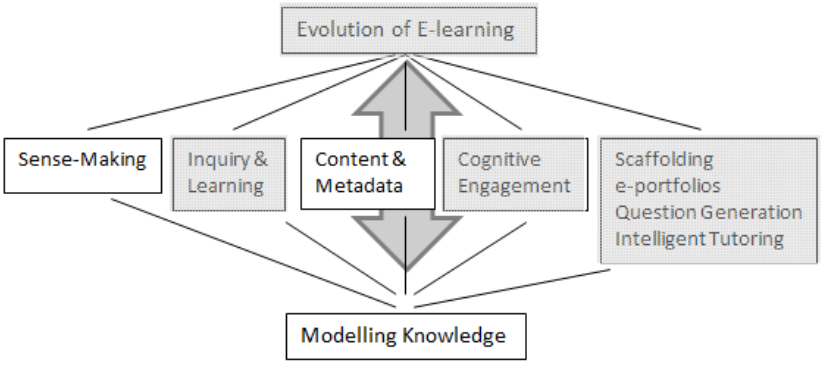


*Figure 6.1.* Topic focus of Chapter 6.

*Figure 6.1* is used here as a partial representation of *Figure 1.4*, highlighting the linkage between key topics within this paper – sense-making, content and metadata, and modelling knowledge.

# Knowledge Management and Dublin Core

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## Abstract

This paper is concerned with investigating existing and potential scope of Dublin Core metadata in Knowledge Management contexts. Modelling knowledge is identified as a conceptual prerequisite in this investigation, principally for the purpose of clarifying scope prior to identifying the range of tasks associated with organising knowledge. A variety of models is presented and relationships between data, information, and knowledge discussed. It is argued that the two most common modes of organisation, hierarchies and networks, influence the effectiveness and flow of knowledge. Practical perspective is provided by reference to implementations and projects providing evidence of how DC metadata is applied in such contexts. A sense-making model is introduced that can be used as a shorthand reference for identifying useful facets of knowledge that might be described using metadata. Discussion is aimed at presenting this model in a way that both validates current applications and points to potential novel applications.

**Keywords:** KM; knowledge; sense-making; DC; metadata; knowledge management; models; KOS; knowledge organization systems.

## 1. Introduction

The application of Dublin Core (DC) metadata for information management purposes has been taking place ever since the 15 simple DC elements were developed. Its application for industry-specific purposes such as education or government service identification has also been widely adopted, though not without challenges along the way.

Knowledge Management (KM) presents an interesting set of challenges for those interested in utilising DC metadata because it can be perceived as a number of different things – as an academic discourse, an organisational intervention, a set of activities that a community of practice might undertake to ensure optimum knowledge flows, or even what an individual might do to maximise the reuse and retrievability of their own knowledge. To underscore this challenge, it is a very interesting exercise just to find a broadly accepted definition of KM that might be both flexible and comprehensive enough to deal with all these scenarios.

Although KM first emerged in the 1980s it only began to seriously establish in the mid 1990s when the impact of the Web was just beginning to be felt upon the business world. As such, its early character was biased toward business process improvement from a managerial perspective. The influence of networks upon the way KM has been understood or implemented is something that has only emerged in later discourse (Beerli, et al., 2003; Back, et al., 2006).

It has been argued that the fundamental KM problem is all about changing organisational 'silos' of activity (manifest in organisational divisions, hierarchical management structures, projects, work teams, documents, and individual workspaces) so that knowledge flows more readily, is shared and leveraged for maximum benefit, and is not pigeonholed nor rendered inaccessible through poor information management practices (Xu and Quaddus, 2005: 382). Such a problem will likely resonate for most people who are employed by organisations. However, while this 'silo' problem is clearly evident within hierarchically structured organisations it is also manifest within networks, and it is commonplace for potentially synergistic communities of practice to actually exist more as disconnected 'islands'. The problem is in fact a deeper one, and

is to do with the nature of knowledge and organization—hierarchies and networks are the two most effective forms of organisation that human beings have yet created; both have their place, but it will always be the situational context that will suggest the most effective way to act.

Another challenge concerning KM for the DCMI community is that it represents a domain that is arguably more expansive than all other communities currently developing application profiles. Thus, a definition of Knowledge Management that might be useful for the DCMI KM community to consider is presented here:

> Knowledge Management (KM) finds expression as both an *organisational intervention* aimed at delivering better efficiencies in the handling of knowledge, and an *academic discourse* that develops theoretical frameworks and practical techniques for managing the entire knowledge lifecycle from a variety of perspectives: individual, community, and organisational. It *can*, though doesn't need to, involve a multiplicity of considerations and tasks and is always influenced by context.

### 1.1. DCMI KM Community

The DCMI Knowledge Management Community was established in mid 2007 as "a forum for individuals and organisations with an interest in the application and use of the Dublin Core standard in knowledge management." (DCMI, 2007) To some extent this new community provides continuity with issues addressed by the DCMI Global Corporate Circle, which was deactivated in 2007. To date, while there is clearly an interest in this area with over 120 subscribers to the email listserv there is little serious documented discourse. This paper therefore aims to make a contribution by presenting some theoretical framework for consideration, providing examples of how DC metadata is being effectively applied in some Knowledge Management (KM) contexts, and pointing to current limitations of DC in such contexts.

### 1.2. Overview

The following discussion deals with topics on modelling and organising knowledge from a theoretical perspective. A number of scenarios are then presented, indicating how DC metadata has been effectively utilised for KM purposes. A sense-making abstraction is presented as a reference model for identifying prominent facets or pathways of knowledge that will typically need to be considered in KM contexts. This model aims to validate current applications while also pointing to potential novel applications, thereby indicating any limitations with currently available schemas that may need to be overcome.

## 2. Representing, Modelling, and Managing Knowledge

For knowledge to be organised and managed it is necessary to first establish the scope of such an undertaking. This task has been approached by various practitioners and communities of practice in a broad variety of ways. The proceeding discussion is an attempt to summarise some of the more prominent approaches that have relevance for the application of DC metadata.

The field of Computer Science provides at least two key (mutually informing) approaches – through formal knowledge representation languages such as Prolog, the Resource Description Framework (RDF), the Web Ontology Language (OWL), and Attempto Controlled English (ACE); or, through conceptual classification into three categories: declarative, procedural, and conditional knowledge. Declarative knowledge is expressed by explicit statements of the kind 'it is known that' and typically involves facts or 'objective' information; procedural knowledge is typically expressed by statements that represent 'know-how'; and, conditional knowledge is represented by statements that represent 'knowing-if' and/or 'knowing-why' (Murphy, 2008).

Through recent years of work on developing a robust 'abstract model' that can inform future extensibility and application of DC metadata, the Dublin Core Metadata Initiative is now strongly aligned with the knowledge representation capabilities of RDF (Powell, et al., 2007). It is

noteworthy that this work has taken both considerable effort and time and has required ongoing explication through other documents such as the Singapore Framework (Nilsson, et al., 2008). This work has also demonstrated that the goal of defining and using shared semantics is not sufficient for sustainable knowledge sharing in Web environments—for this to occur, semantics must be associated with statements that make clear certain relationships, thereby establishing context through syntax and structural relations.

Another approach is to situate knowledge within its relationship to data, information, and wisdom as a value hierarchy and is often depicted as a pyramid (see Figure 1).

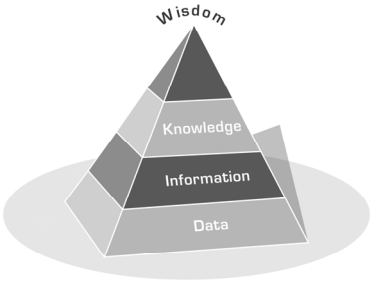


FIG. 1. Traditional value pyramid representing knowledge

However, just as the Internet has rendered geographical boundaries and legal jurisdictions as debatable constructs when it comes to information flows, the boundaries that separate data, information, and knowledge can be very fuzzy and depend upon context. Thus, in the context of the Internet, Figure 1 becomes a very poor representation for the simple reason that data, information, and knowledge become intermeshed. In this environment value can be created through rendering information and knowledge as data and many datasets can either comprise or be extracted from a knowledge-base. In short, this inverts the value-chain depicted by the pyramid (Mason, et al., 2003). Capturing explicit knowledge and organising it as structured information for sharing and reuse is thus one of the powerful features and potentials of the Web.

This same recursive property can also be seen with metadata. While it is pragmatic that simple models identify 'digital assets' or content as one entity and 'metadata' as another (that describes the content) such models can mask deeper complexity. For example, in the case of a repository designed to broker resource discovery, the assets it gathers into a collection might only be metadata records but collectively they represent useful content – thus, 'one person's metadata may be another's content'; ultimately, it is the context that determines this (Mason, 2004).

But there is another reason why Figure 1 is not adequate for the Internet and that has to do with the important role that metadata has in the organisation, structuring, presentation, and sharing of content and services—metadata being defined as data associated with or descriptive of other data, information, knowledge, or services. As such, metadata can be expressed in many forms—examples include the manifest file associated with a 'learning object', XML tags, user-defined tags, or explicit information such as authorship or publication date of a piece of content. A more accurate representation would therefore be something like what is depicted in Figure 2.

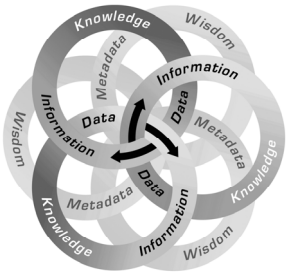


FIG. 2. Meshing of Data, Information, Knowledge and Metadata

Yet another approach, from the field of Knowledge Management, was inspired by Polanyi (1966), who distinguished between explicit and tacit knowledge. Nonaka and Takeuchi (1995) developed this concept further and proposed a dynamic model that represents the management of (organisational) knowledge as interactions of tacit and explicit knowledge throughout four ongoing processes involving socialization, externalization, combination, and internalization known as the "SECI model". As both an academic discipline and an organisational intervention the field of KM has developed considerably in the past decade and is replete with many more detailed models that both draw upon and challenge this foundational work (Snowden, 2002; Earl, 2001; Firestone and McElroy, 2002; Rao, 2005; Wierzbicki, 2006). Thus, while the core concepts of the SECI model continue to be recognised as important by KM practitioners the world over, there is an underlying shift in paradigm from a *principle of reduction* toward a *principle of emergence* that is important to highlight (Wierzbicki, 2006:1-13). The work by Snowden (2002, 2005) on complexity, story-telling, and sense-making is representative of this shift. Likewise, Seufert, Back, and von Krogh underscore the importance of networks for KM to develop:

> Concerning the integration of networking and knowledge management, we believe two aspects to be crucial. First, knowledge management should comprise a holistic view of knowledge, meaning the integration of explicit and tacit knowledge. Furthermore, knowledge management should take a holistic view on where and how knowledge is being created and transferred … *The integration of networking into knowledge management yields great benefits. The openness and richness of networks … foster a fertile environment for the creation of entirely new knowledge.* [My emphasis]
>
> (Seufert, et al., 2003)

The influence of networks and networking upon KM suggests then that there is scope for developing updated models of knowledge. This is particularly so, given that hierarchies have historically been the dominant mode of organisational structure; however, while harnessing the flows of knowledge shared within networks would appear to be a natural domain for KM the theory and practice of doing so is not so straightforward. This is borne out in a blog post by Sims (2008) in which an analysis of 53 Knowledge Management definitions is presented:

> General observation: this again illustrates the definition diversity. It is not like these are 53 definitions with slightly different word choice. These are substantially different. There are only five attributes that are seen in 30% or more of the definitions: KM is a process, it is targeted at the organization (company), it deals with knowledge, sharing is part of the story, and the definition includes a "why". (Sims, 2008)

Thus, it can be seen that the discourse on KM has developed considerably in the past 15 years. In an attempt at summing up the dimensions of 'emergence' and 'complexity' while not trivializing them Snowden advocates a characterization of the "paradoxical" nature of knowledge "as both a thing and a flow" (Snowden, 2002). As such, an adequate model of knowledge needs to convey dynamism and the tasks associated with organising knowledge involve far more than the description and classification of information resources—it involves both the *tacit* and *explicit* dimensions of knowledge. Obviously, metadata can only successfully be applied to explicit knowledge—so, is there another approach that can approximate a holistic view of managing knowledge? Could such a model point to new applications for metadata?

## 2.1. A Faceted Model

While all the preceding approaches can be shown to be useful a faceted model is presented as a means of identifying the critical pathways of knowledge in KM contexts (see Figure 3). This model is based upon earlier work in Norris, et al., (2003) and further refined in Mason (2007).

This model represents an attempt to summarise the key pathways for consideration while an individual is engaged in learning, thinking, or knowing. It has been developed as a device that might assist in providing a 'shorthand' reference of considerations when approaching the

development of an e-learning activity or a KM task. The model represents 'primitive' questions associated with query generation or proposition development (*Who, What, When, Where, How, Why,* and *If*). These seven knowledge facets are situated within three key influences: content, community, and context following Seely Brown (1999. p. ix).


FIG. 3. InterCog Sense-Making Model

Out of these seven primitives *Who, What, When,* and *Where* can be seen to function primarily as the primitives of organised information retrieval and resource discovery – particularly within the Internet. This can easily be validated by investigating the essential characteristics of metadata schemas used to describe information resources such as proposed by the DCMI Kernel Community (Kunze, 2001; Mason and Galatis, 2007). It is not yet clear to what extent the *Why, How,* and *If* primitives function as catalysts in the development of *understanding* but they can be seen as important questions in many activities that involve the creation, sharing, and management of knowledge. Of the latter three primitives, *How* and *If* can be seen to typically generate procedural or rule-based knowledge. *Why*, however, presents a significant challenge to deeper modelling, primarily because of its breadth of usage. Unlike the *descriptive* primitives (*Who*, *What*, *When*, *Where*, and to some extent, *How*), *Why* gives emphasis to the *explanative* dimension in which facts can be subject to greater subjective perspective. In teaching contexts *Why* is used as a question to help learners adopt a critical, reflective approach to the content they must interact with. In KM contexts, understanding why a certain communication protocol is important or why certain procedures need to be followed can make all the difference to how these things are operationalised. *Knowing-why* can also help build "strategic insight" (USDA FS, 2005:6).

There are a number of assumptions that underpin this model, not least of which is the choice of utilising a circular graphic—the assumption being that the relationships between all entities within it are closely interdependent. It is therefore instructive to consider recent literature focused on identifying transitions in knowledge creation that most models are presented as spirals (Wierzbicki and Nakamori, 2006). It is therefore acknowledged that this model could be improved and may need to be tested rigorously and modified.

## 3. Organising Information

Information can be organised in a multiplicity of ways—in library and enterprise settings the default method is through the application of hierarchical structure, based upon authoritative classifications and taxonomies (such as the Library of Congress Subject Headings or Dewey Decimal Codes); in Web environments, the power of association through hyperlinks is exploited; and, in a seemingly chaotic pile of papers on an office desk. In each case, *structure* and *relation* combine as the key organising principles.

Focusing on semantics, as the DCMI community and Semantic Web community have done since first being established, also represents a powerful way to organise and discover information. The simple (but extensible) semantics of the Dublin Core represent an elegant simplification of

traditional library cataloguing semantics for use in Web environments. Following this achievement, it is arguable that the even simpler semantics proposed by the DCMI Kernel Community represent an important future key to innovative approaches to metadata interoperability (Kunze, 2001). The application of DC metadata to describe and enrich information resources has proven to be an effective method of managing information for later retrieval and reuse. In fact, metadata can be seen as a key component in managing information resources, But the question arises: to what extent can it be used in *organising knowledge*?

## 4. Organising Knowledge

For as long as knowledge has been preserved it has also been organized—whether in the context of non-literate societies such as Indigenous Australians stewarding knowledge through story and song; in the context of the *I Ching*, the first Chinese book ever written and focused on 64 core life scenarios to navigate; or, in the classification of newly identified plant species according to authoritative taxonomies.

Hypertext Markup Language (HTML) can be seen as a key contemporary technology that enables knowledge to be organised through rich associative links. Through combining hypertext with Internet transmission protocols HTML has enabled the Web to become a vast networking platform for connecting information and communication resources. While human societies have always benefited from networking, the scale and reach of networks now available is fundamentally a new development in human history and in the organisation of its disparate knowledge sources. Of course, most of the developed world now takes all this for granted.

With recent developments in Semantic Web technologies and Web 2.0 applications there now exists further capacity for organising and sharing knowledge; however, the flipside of this story is that innovation is so extensive there is also a chaotic dimension to the proliferation of knowledge and networks. As soon as a new way of organising or combining knowledge becomes available new 'islands' or 'silos' of activity emerge and 'networks' soon become 'clubs' or 'tribes' that rely on conventions and protocols to participate.

'Emergence' is a concept that describes a scientific paradigm for our times in more meaningful ways than a scientific reductionist paradigm does (Wierzbicki and Nakamori, 2006)—but dealing with the pragmatics of this can be challenging to say the least! It is therefore arguable that in the same way that Jean-Paul Sartre made the famous comment that "man is condemned to be free" that no matter what knowledge we create we are condemned to make new sense of it in new contexts (Sartre, 1966). Just because knowledge may reside within an 'open architecture' platform doesn't render it as operational, and it certainly doesn't guarantee that it will flow.

Because of the many methods of assigning order to otherwise unstructured information the *Knowledge Organization System* (KOS) is used to describe such methods. Examples include classification schemes, thesauri, taxonomies, controlled vocabularies, and subject headings. This term has been used as the basis for a relatively new Web technology, known as the *Simple Knowledge Organization System* (SKOS), which is aimed at providing a common data model for the exchange of data between the kind of KOS referred to above (Miles and Bechhofer, 2008).

All these developments in technologies underscore that the application of metadata in any KM context represents just one component of a broader concern. In other words, metadata alone does not provide a complete solution for KM. Moreover, despite the use of the word 'knowledge' in technologies such as SKOS, it is important not to lose sight of the fact that such systems only represent a subset of knowledge. Furthermore, as Ray argues,

> Data models are insufficient to enable widespread system interoperability, and organizations need to develop an ontology to explain how different data elements interact. Only when this context is rendered in a computational form can external systems make sense of a data model. (Ray, 2009 quoted by Jackson, 2009)

### 4.1. Other Requirements

Because Knowledge Management is concerned with maximizing the potential application for both tacit and explicit knowledge, certain practical limits govern the application of DC metadata.

In some KM contexts the 'reusability' of information or knowledge may be limited to basic metadata; however, in some corporate settings other metrics will apply. For example, the 'trustworthiness' or 'reliability' of the content or its source may depend on local or tacit knowledge about its origins; quality assessment will have industry-specific conventions; the ability to integrate diverse vocabularies in supporting IT infrastructure; the degree to which performance-support can be provided; how to prepare knowledge for transfer to contexts as yet not identified; what business analytics can be discerned; and, then there are security and privacy concerns. All these are issues for KM.

Many KM practitioners also place emphasis upon *story* as a means to communicate important lessons from the field. In terms of the model discussed in Figure 3, aspects of story align well with the facet *know-why*. The challenge becomes: *how* to use a DC approach in developing an appropriate schema to capture this?

## 5. Practical Perspectives

The following cameos are presented to indicate the diversity of implementation contexts in which Dublin Core metadata is currently used for KM purposes.

### 5.1. Ohio State University Knowledge Bank

The Ohio State University Knowledge Bank (OSUKB) represents an exemplar in University institutional repositories in the way it integrates diverse digital assets, is well-positioned to interoperate (or federate) with other 'open access' repositories, and the project "places its institutional repository in the larger context of a multifaceted knowledge management program" (Branin, 2004). The OSUKB also represents an example of the evolutionary path that academic libraries have navigated in recent years from "collection development to collection management to knowledge management" (Branin et al., 2007).

Apart from the value of knowledge sharing with peers, the core value proposition presented to students in order to enlist their participation in using the Knowledge Bank is as a safe, high quality, managed repository in which to store and preserve outputs of their work for later use and or discoverability by others (OSU, 2009). This is clearly an important component of an individual student's KM requirements. It also serves the purposes of the institution in that it represents an aggregation of intellectual outputs that will expand over time.

The OSUKB is an implementation of DSpace software and its Metadata Application Profile is based upon qualified Dublin Core (OSU, 2008). Specific additional requirements, such as managing Intellectual Property Rights, are handled via Creative Commons licensing. The OSUKB approach to KM represents a typical repository approach found throughout higher education settings worldwide. As such, the KM infrastructure that is implemented places emphasis on the management of scholarly outputs or content as the primary object for knowledge management.

Despite acknowledging the broader KM agenda beyond the storage and retrieval of content to involve the "social life of information," it is clear that there is a long way to go for other aspects of KM to be implemented as services that enhance the OSUKB—if Figure 3 is considered.

### 5.2. The Corporate Sector

While there is plenty of evidence that the corporate sector uses metadata to manage its assets, there still seems to be selective adoption of DC metadata. In fact, a recent book published with the title 'Business Metadata' (Inmon, et al., 2008), does not even contain *one* passing reference to

DC metadata! This underscores the findings in a 2005 report developed for the DCMI Corporate Circle:

> Except where there is a business or regulatory requirement to share information, the private sector has little interest in interoperability with repositories outside their organisation. Most applications that seek to gather metadata into databases so that document-like content can be found and re-used when needed, occur behind the firewall. … [while there is] wide usage of Dublin Core in this context … there is an unwillingness and inability to share the details of that experience widely. (Busch, et al., 2005)

This suggests that while some metadata infrastructure is being put in place to accommodate internal organisational *information management* requirements there is a long way to go before a holistic approach to KM metadata requirements in the corporate sector is achieved.

### 5.3. Semantic Web

With the development of the DCMI Abstract Model there is now exists better theoretical alignment with capabilities of RDF and hence the Semantic Web. The implications for KM of this are neatly summed up by Lamont (2007):

> The Semantic Web is relevant to knowledge management because it has the potential to dramatically accelerate the speed with which information can be synthesized, by automating its aggregation and analysis. Information on the Web now is typically presented in HTML format, and while very beneficial in some respects, the format offers neither structure nor metadata that is useful for effective management.

Cho (2009) echoes this view by arguing the role that Dublin Core has played in "knowledge management activity representation" is a key factor to future success of the Semantic Web. However, identifying significant Semantic Web implementations in KM contexts has not as yet been fruitful.

## 6. Conclusion

This paper has focused on being explicit about conceptual foundations in modelling a domain of activity – in this case, Knowledge Management. Following on from the Singapore Framework (Nilsson et al., 2008) this can be seen as an important step prior to developing any metadata schema that might assist in managing data, information, or knowledge relevant to that domain. The primary challenge concerning KM for the DCMI community, however, is that KM represents a domain that has a more expansive scope than other communities currently developing application profiles. The sense-making model presented indicates some potential new scope for the application of DC-based metadata in relation to accommodating *explanative* metadata.

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**Key Contributions of Paper 4**

This conference paper makes the following contributions to this thesis:

Firstly, it introduces a conceptual framework that situates theoretical foundations on why and how the field of knowledge management is relevant to Dublin Core metadata, and therefore, the management and discovery of digital content.

Secondly, it focuses on issues associated with modelling knowledge and therefore the challenges involved in developing formal metadata schemas that describe and identify content.

Thirdly, it specifically identifies challenges and opportunities associated with *knowing-why* and *why*-questioning.

Fourth, it identifies ways in which metadata and knowledge organisation systems are used in the management of information and content.

Fifth, it makes a clear distinction between descriptive and explanatory content – and by corollary, points to a future explanatory function for metadata schemas.

Finally, in terms of the overall outcomes of this study, the conceptual underpinnings of this paper are constrained by issues associated with semantics. While the topic of semantics is of central concern to stakeholders involved in the curation and management of digital content – in other words, individuals and organisations with more than a passing interest in metadata – the *why dimension* is a construct that is shown to have a sense-making function that is not reducible to issues of semantics.

# Chapter 7: Cognitive Engagement and Questioning Online

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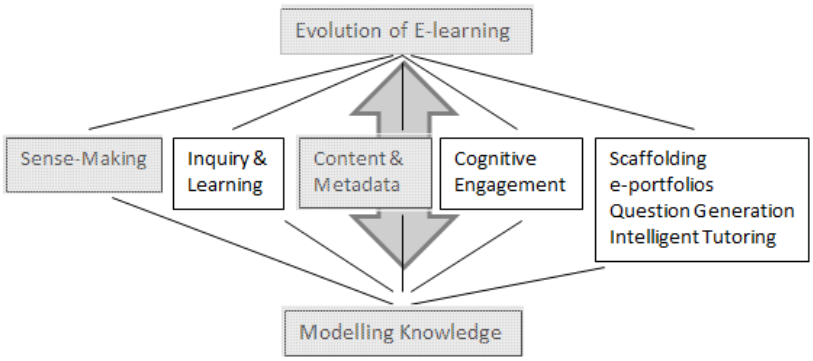


*Figure 7.1*. Topic focus of Chapter 7.

*Figure 7.1* is used here as a partial representation of *Figure 1.4,* highlighting the linkage between key topics within this paper – inquiry and learning, cognitive engagement, and scaffolding.

# Cognitive engagement and questioning online

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This chapter discusses a range of issues associated with supporting inquiry and deep reasoning while utilising information and communications technology (ICT). The role of questioning in critical thinking and reflection is considered in the context of scaffolding and new opportunities for ICT-enabled scaffolding identified. In particular, *why*-questioning provides a key point of focus and is presented as an important consideration in the design of systems that not only require cognitive engagement but aim to nurture it. Advances in automated question generation within intelligent tutoring systems are shown to hold promise for both teaching and learning in a range of other applications. While shortening attention spans appear to be a hazard of engaging with digital media cognitive engagement is presented as something with broader scope than attention span and is best conceived of as a crucible within which a rich mix of cognitive activities take place and from which new knowledge is created.

**Keywords** why; question generation; deep learning; reflection; knowledge ecology; intelligent tutoring; scaffolding

## 1. Introduction

Developments in information and communications technology (ICT) since the invention of the World Wide Web have provided enormous stimulus for innovation in teaching and learning. In practice, there exist numerous trajectories of innovation relevant to e-learning: learning management systems (or virtual learning environments), intelligent tutoring systems, e-portfolio systems, performance support systems, gaming environments, and other related applications have all provided structured approaches to teaching and learning online; mainstream search engines have enabled easy access to an ever-expanding information environment and informal learning; and Web 2.0 applications and services have unleashed the latent social networking potential intrinsic to the 'architecture' of the Internet, enabling knowledge sharing at a scale never previously possible. Despite such rapid advances a number of debates concerning the cognitive impact of mainstream practice have started to emerge in recent years. For example, advocacy of the enabling character of these technologies describes benefits such as facilitation of "multi-tasking" and "extending interaction" [1] while, conversely, critics characterize IT as an "interruption technology" that weakens cognitive focus [2]. Such debates can be seen as a natural cycle and their existence represents a maturing of discourse within the field of e-learning.

Much of the commentary regarding the negative impact of the Web on cognitive ability is not just confined to the discourse on learning with ICT. The emergence of the so-called '24-hour news cycle' suggests that the increased scrutiny by the news media of politicians and their policies creates a bias toward the headline, often hyped, five-second newsbyte as a prime driver of the news. Among other things, this brings the consequence that the ability to communicate a narrative over time is compromised by both the nature of the technology and media cycle itself, both of which are calibrated to exploit short attention spans. It can also be argued that this is happening as a consequence of the amount of information that is readily accessible – information that is now being produced through increasingly diverse channels from increasingly more sources and is yielding increasing layers of complexity for 'knowledge workers' to interact with and create value from [3]. And so, because the production and sharing of knowledge largely depends upon information that is well organized and structured, transforming all this information into knowledge that has operational utility represents a key challenge – that is, if the age we live in is to be accurately characterized as the Knowledge Age.

This chapter picks up these themes as a challenge and is focused on identifying possibilities for the development of ICT scaffolding that supports cognitive engagement through in-session reflection, question-asking, and deep learning. Recent developments in research associated with Question Generation (QG) and Question-Answer (QA) techniques hold much promise for opening up a new frontier for e-learning and intelligent tutoring. In particular, this chapter looks closely at questions initiated by "*why*". Why? There are numerous answers. Unlike the most basic questions of resource discovery and information retrieval (*who, what, when,* and *where*) that are suitably answered by clear-cut facts, *why* questions can be categorized into various types, such as motivational, circumstantial, teleological, or causal – typically demanding an explanation as an 'answer' or response [4-6]. Evidence also suggests that purpose-built ICT support for probing and sustained questioning in e-learning environments appears to be currently undeveloped – despite significant progress in natural language search engine technology [7]. It is therefore arguable that the 'fast-food Google paradigm' of search that delivers an amazing collection of relevant results is still biased toward the 'aboutness' of content, and does not easily probe its explanative potential.

It is clear that e-learning is evolving in both theory and practice. It is also clear that there already exists a range of powerful ICT tools that facilitate learning and the sharing of knowledge. All going well, considered foresight suggests that a Wisdom Age might even develop at some stage in human history [8]. But before that emerges, it will be important that there is some kind of 'completeness' to the learning and knowledge creation tools available. We will

 

soon need to deploy tools that help us manage the *Know-Why, Know-How,* and *Know-If,* as effectively as the *Know-What, Know-When, Know-Where,* and *Know-Who*.

This chapter first discusses issues associated with questioning (in particular, *why*-questioning), its role in learning and its scope of use within ICT-enabled learning environments. This provides the context for discussion on scaffolding facilitated by ICT in which a number of issues are raised concerning the design and implementation of ICT systems. Issues concerning cognitive engagement are presented together with opportunities arising from recent advances in the areas of Question Generation and Question-Answer research.

## 2. Questioning and Learning

Asking questions is an important foundation of learning [9, 10]. The Inquiry Project at the University of Illinois, a project focused on the advocacy of inquiry-based learning spanning ten years, took an even stronger stance, using as its motto: "learning begins with questions" [11].

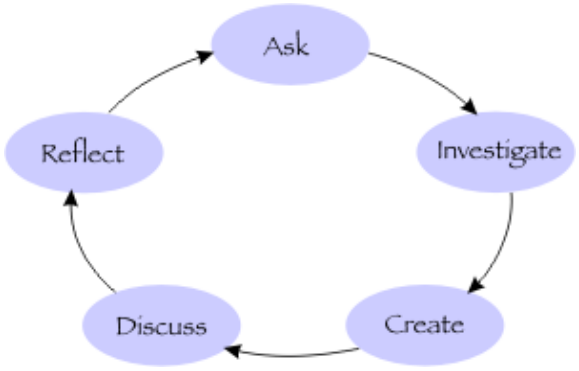


**Fig. 1** The primary graphic of the University of Illinois Inquiry Project (2001-2010) representing a virtuous circle of activities associated with inquiry.

While learning can clearly take place without questioning – for example, through repetition and memorization – it is through questioning that reflection, discourse, analysis, and knowledge construction take place. Consistent with this perspective, socio-cultural philosophers of education, Freire and Faundez, have argued for the need for a "pedagogy of asking questions" that gives emphasis to the questioning process as something valuable in itself, where the 'answer' may not even be relevant: "Thinking about questions that may not always or immediately arrive to an answer are the roots of change" [12]. More recently, Thomas and Seely Brown identify the emergence of a "new culture of learning" as a consequence of innovation with ICT and make the argument:

> We propose reversing the order of things. What if, for example, questions were more important than answers? What if the key to learning were not the application of techniques but their invention? What if students were asking questions about things that really mattered to them? [13]

What if, indeed! According to the 1944 Nobel Laureate in Physics, Isidor Rabi, when asked how he came to be a scientist he answered as follows:

> My mother made me a scientist without ever intending it. Every other Jewish mother in Brooklyn would ask her child after school, 'So? Did you learn anything today?' But not my mother. She always asked a different question, 'Izzy,' she would say, 'Did you ask a good question today?' That difference – asking good questions – made me a scientist. [14]

### 2.1 Socratic Questioning

The art of asking questions that help elicit the truth, reveal misconceptions and assumptions, or just the discovery of richer perspectives was most famously developed by Socrates as a pedagogical technique nearly twenty five hundred years ago [15,16]. For Socrates, dialogue was paramount in revealing poor argumentation and prejudice; while probing questions help cultivate reasoning skills. Much of the more contemporary literature on scaffolding can be shown to have roots in what is now termed 'Socratic Method' or Socratic Questioning' [17-22]. In some ways and somewhat ironically, implementation of the Socratic Method can be seen as blurring the boundary between the roles of teacher and mentor. Although Socrates succumbed to transgressing the law and was convicted of corrupting the young he was regarded by many of his peers, as well as countless scholars since, as being considerably wise. His approach is clearly durable and the close interdependency of questioning and dialogue that is a prominent characteristic aligns closely with the contemporary approach of Figure 1.

So, what distinguishes Socratic questioning from other questioning? According to Paul and Elder "Socratic questioning is *systematic, disciplined,* and *deep* and usually focuses on foundational concepts, principles, theories, issues, or problems." [23] However, *curiosity* is also an essential requirement for it to proceed effectively – for the simple reason that an inquisitive mind is voluntary. The roots of the critical thinking movement in education can likewise be traced to Socrates, for its goals of clarity of thought and the pursuit of truth are similar, although critical thinking is more explicit about the importance of 'metacognition', or thinking about thinking. From a pragmatic perspective, Paul provides a useful classification of Socratic questions as summarised in Table 1 [24]. In subsequent work, Paul and Elder define three categories of Socratic Questioning: "spontaneous, exploratory, and focused" [25]. These 'categories' are better described as modes of delivery that together represent a pragmatic pedagogical perspective aimed at cultivating and maintaining student interest. Importantly, Paul and Elder have found that while questions can be classified, the *practice* of effective Socratic Questioning demonstrates that context must always shape the process – hence, any prescriptive lists of questions will invariably falter.

**Table 1** Adaptation of Paul's classification of the Six Types of Socratic Questions [24]

| Type of Question | Examples |
|---|---|
| Questions that require clarification | *Why did you say that?*<br>*What does that mean?*<br>*How does this relate to your earlier statement?* |
| Questions probing assumptions | *Can that statement be validated?*<br>*What beliefs are assumed here?*<br>*Might there be other agendas involved by those who are making these claims?* |
| Questions probing reasoning and evidence | *What do you think the causes are? And why?*<br>*Is there any evidence or facts that support this?*<br>*How complex is the issue?* |
| Questions probing perspective | *Is there another way to look at this?*<br>*What are the arguments to the contrary, if any?*<br>*Can you provide an overall rationale?* |
| Questions probing implications | *What consequences can you see arising?*<br>*Can a generalisation be made?* |
| Questions about the question | *Why is this question relevant?*<br>*What does this mean in practical terms?* |

Having endured a considerable test of time Socratic Questioning therefore represents an important consideration in the design and implementation of ICT systems that aim to support learning. It also represents a challenge for any automated approaches given its highly contextual and interactive requirements.

### 2.2 Asking why

If *understanding* is the goal then asking *why* is arguably one of the most commonplace acts of inquiry. 'Why' questions are characteristic of the early years of language and cognitive development and it is certainly typical for a young child to ask *why* questions in order to understand the world better [9, 26]. Commenting on Piaget's seminal work in the area of developmental psychology Otero adds that there is a connection between *cognitive obstacles*, learning, and the need to ask *why*:

> According to Piaget, a conception of the world where chance plays a very limited role explains why children from approximately 3 to 7 years of age ask so many *Why* questions. In contrast to adults, who rely on chance and contingency to explain many phenomena, children believe in a highly predictable world where chance plays a lesser role. Assuming there is very limited room for chance in their mental representations of the world, many events and states that are not problematic for adults turn out to be full of obstacles for children. [27]

For older children as well as young and older adults *why*-questioning remains important throughout life in a multiplicity of contexts – such as social conversations, eliciting explanations, scientific analyses, legal proceedings and formal education [28]. Yet, it is the case that the tools that facilitate inquiry on the Web – despite being extraordinarily powerful – are overwhelmingly configured toward responding to queries in the form of subject keywords and phrases. Why is this so? One explanation is that the most basic questions of resource discovery and information retrieval are instigated by the 'primitives' *who, what, when,* and *where* [4]. All such primitives are associated with factual information; they describe facts, persons, events and places, and therefore provide straightforward information for search engines to gather and return as results. But if we are concerned with processes of teaching and learning then

there are other important questions to consider. Learning, education and training involve more than the retrieval and exchange of information and content that is well described by facts associated with questions of *who, what, when,* and *where*. Clearly, some of these questions will be instigated by *how* and *why*.

The problem with *why*-questioning is that layers of complexity are introduced making it considerably more challenging to build ICT systems that can parse information to adequately to support it. *Why*-questioning often requires further contextual information to satisfactorily provide an 'answer' (e.g., *why are flights grounded today?* the search engine may be configured to look at *where* the questioner is located as well as the time of day and infer a set of results, but this may not be the case). *Why*-questioning raises questions of motivation and purpose (e.g., *why did Obama run for Presidency of the United States?*) in which there is likely to be no clear-cut answer. *Why*-questioning often involves consideration of causality (e.g., *why is cancer a difficult disease to cure?*). In some cases, a *why*-question may point to a straightforward scientific answer (as in *why does salted water boil at a higher temperature to pure water?*) but in others will introduce politics and opinion (as in *why are the Israelis and Palestinians caught up in such intractable conflict?*). *Why*-questions can also touch upon wonderment and existential angst (e.g., *why can't scientists explain what caused the big bang?* and *why do we need to sleep?*). Importantly, in most cases *why*-questioning demands an *explanation* or *rationale* as an adequate response.

### 2.3 Classifying *why*-questions

Researchers from a diversity of fields – such as computational linguistics, discourse analysis, psychology, artificial intelligence, knowledge management, and intelligent tutoring – have recognised these issues and analysed *why*-questions for many decades [4-7, 27, 29, 30]. The fact that there is such a diversity of researchers involved immediately indicates the cross-disciplinary nature of the challenge.

Another dimension to this challenge arises because of the versatility of the word *why* itself. Not only is the word *why* commonly found in questions but also within a range of other linguistic expressions. From a grammatical perspective it can function as an interrogative (simply as *Why?*), an adverb (as in *Why do we sleep?*), as a pronoun (as in *There is no reason why she shouldn't attend*), as a noun (as in *He provided an analysis of the question why*), and as an interjection (as in *Why, you're crazy!*).

One way of classifying *why*-questions is from a linguistic perspective, as in Table 2.

**Table 2** Common forms of *why* questions*

| |
|---|
| Why do/does/did ... |
| Why is/are ... |
| Why can ... |
| Why then ... |
| Why will ... |
| Why has/have ... |
| Why may/might … |
| Why should … |
| Why could … |
| Why [noun / verb / phrase / proposition] |

* Assumes associated negative counterparts (*Why don't?* etc.)

In another approach, Evered details a "typology of explicative models" in which the explanatory function of responses to *why*-questions is classified into three classes of explanation:

Causal: (*Why E? Because C* (C= cause));
Teleological: (*Why E? In order to P* (P = Purpose)); and
Gestaltic: (*Why E? For these reasons, R* (R = Reasons)) [6]

Evered's classification provides a succinct framework; however, the challenge of utilising this in the context of teaching and learning facilitated by ICT is yet to be realised.

More recently, Verberne has presented an analysis on *why*-questioning focused on linguistic structures and components that can inform the design of effective automated question-answering (QA) systems [5]. QA research had its beginnings in the field of information retrieval (IR) during the mid-1990s and has since developed a significant and mature discourse [30]. Verberne's classification identifies four kinds of *why*-questioning after close discourse analysis and "distinguish[es] the following subtypes of reason: cause, motivation, circumstance (which combines reason with conditionality), and purpose" [5]. However, Verberne shows that while such classifications can be helpful they are not

sufficient – certainly not for the purpose of informing the design of automated ICT QA systems. Importantly, despite her expectation that algorithms focused upon reasoning would likely provide most guidance on the design of any effective automated answering system, her work on linguistic structure and relation reveals that "elaboration is more frequent as a relation between a *why*-question and its answer than reason or cause". This key finding has helped Verberne develop a number of related algorithms informed by IR and Natural Language Processing (NLP) techniques that together demonstrate an effective approach to ICT systems design for answering *why*-questioning [5]. Despite achieving close to 60% effectiveness in answering *why*-questions, and what would seem to be respectable results, Verberne concludes:

> high-performance question answering for *why*-questions is still a challenge. The main reason is that the knowledge sources that are currently available for NLP research are too limited to capture the text understanding power that is needed for recognizing the answer to an open-domain *why*-question. Since this capability is problematic for machines but very natural for human readers, the process of *why*-QA deserves renewed attention from the field of artificial intelligence. [5]

Such a statement masks the progress already made; however, if we consider the discussion on Socratic questioning in which questions are not regarded in isolation but as part of a sequence of other questions all contextually related then Verberne's conclusion is probably an understatement! Automating a Socratic interrogation seems like it will take more than renewed attention from the field of artificial intelligence.

### 2.4 Explanation as a response

There is a flipside to the linguistic versatility of the word *why*: it can also be perceived as semantically ambiguous. This ambiguity contributes to some extent to the requirement that adequate responses to *why*-questions therefore either lead to further dialogue or need to be explanatory. This becomes a complex task for ICT systems developers.

Early developments in artificial intelligence (AI) during the 1970s produced rule-based systems (based on methods such as 'if-then' tree chaining) that were capable of delivering crude explanations as responses to queries on a specific knowledge-base that involved both *how* and *why* [32]. Because of the multiplicity of question types it was soon recognised that question classification schemes were required [33]. These classifications have been improved since then, as described above, and now inform Question Generation (QG) research [7]. However, as Gilbert points out, it soon became apparent within the AI community that it was just as fruitful to classify *explanatory answers* rather than the questions. These early systems used matrices that provided a small set of explanation types from which to build plausible answers [32]. They might seem crude now but they also can be seen as initiating an important trajectory in ICT research and development.

Since these early days much has been achieved, not only in AI and question-answering but also in the related area of search engine technology. Anyone who uses the Web will be well-acquainted with the awesome power of the sophisticated algorithms that drive Google and other search engines. Despite these accomplishments Google and other mainstream search engines do not yet deal effectively with explanatory content. Some success in this area is only beginning to emerge as a result of developments in Natural Language Processing (NLP). For example, NLP underpins niche search engines like PowerSet [34] and TrueKnowledge [35], and while still in early development, are demonstrating delivery of explanatory material to both *how*- and *why*-questions.

It is also important to emphasize here that explanatory content on the Web is not necessarily text-based and therefore does not have explicit reasoning embedded in it [36]. Ever since multimedia emerged as the mainstream of educational technology development in the years prior to the invention of the Web the education community has benefited tremendously from easy access to powerful visual simulations that explain processes or complex relationships. This is also very true for all sectors of the economy, whether it is benefiting medical practitioners, stockbrokers, meteorological bureaus or real estate sales.

To summarise this discussion on questioning and learning it is appropriate to consider why the preceding discussion on *why*-questioning is so important. In short, it represents a frontier that is informed by research across a diversity of disciplines – a frontier that will likely be chartered with ICT but be informed by techniques of inquiry developed by Socrates and research into the NLP as well as by the ever-expanding resource of visual-based materials. It is very much a work-in-progress. Importantly, it signals an opportunity for research and development of ICT tools that promote reasoning and deep learning. If we are concerned with enhancing the scope and effectiveness of teaching and learning using ICT then there are other important questions to consider beyond the *who, what, when,* and *where* of content for learning. Clearly, questions instigated by *why* achieve this as they are concerned with inquiry and the explanatory nature of content.

## 3. Scaffolding and ICT

### 3.1 Scaffolding learning – the traditional view

In the context of educational theory and practice the term '*scaffolding'* has been typically used to indicate assistance provided by the teacher to the student in constructing knowledge (conceived initially with an 'adult to child' emphasis) [18, 19]. Over time it has evolved in meaning to also include assistance provided by peer learners in the development of understanding and the construction of knowledge [20-22]. Thus, scaffolding is concerned with techniques and tools used to assist in the development and maturation of conceptualisation associated with learning. In other words: "This process of scaffolding is much like the traditional definition of scaffolding as a temporary support system used until the task is complete and the building stands without support" [22].

Following this traditional view and the work of Applebee [31], Foley lists five criteria for effective scaffolding:

1. *Student ownership of the learning event.* The instructional task must allow students to make their own contribution to the activity as it evolves.
2. *Appropriateness of the instructional task.* This means that the tasks should build upon the knowledge and skills the student already possesses, but should be difficult enough to allow new learning to occur.
3. *A structured learning environment.* This will provide a natural sequence of thought and language, thus presenting the student with useful strategies and approaches to the task.
4. *Shared responsibility.* Tasks are solved jointly in the course of instructional interaction, so the role of the teacher is more collaborative than evaluative.
5. *Transfer of control.* As students internalize new procedures and routines, they should take a greater responsibility for controlling the progress of the task such that the amount of interaction may actually increase as the student becomes more competent. [20]

These five considerations represent good constructivist pedagogical principles that are applicable in any formal learning environment, whether ICT-enabled or not. Of course, such principles do not represent the last word on good pedagogy and research by Kapur (2006-2010) has shown conclusively that "engaging students in solving complex, ill-structured problems without the provision of support structures can be a productive exercise in failure" [37]. In reaching such a conclusion Kapur takes a long view beyond the experience of failure itself to recognising the benefits of acquiring skills of adaptability and flexibility during adversity. Thus, there are many circumstances in which leaving students to fend for themselves without structure or support may be better than too much scaffolding. With this caveat in mind it is now useful to consider the impact of ICT on the conceptualisation and implementation of scaffolding.

### 3.2 Scaffolding learning – the role of ICT

With ICT now foremost in the toolset available for teaching and learning a range of new opportunities for scaffolding student learning are available [7, 38-45]. Yelland and Masters go further and argue that:

> in computer contexts extended conceptualisations of scaffolding are needed in order to gain greater insights into teaching and learning processes. Our work has revealed that traditional forms of scaffolding, based on the "expert's" view of how the problem should be solved, need to be modified in order to accommodate the child's perspective and that three different types of scaffolding which we refer to as *cognitive*, *technical* and *affective* can be conceptualized. [46]

In a similar way, McLoughlin and Lee argue that the practical meaning of scaffolding has now "expanded to include learner selected assistance, peer interactions, or could be embedded in technology" [48]. This observation is supported by the argument that "digital literacies" and "self-regulated learning" require scaffolding just as much as "independent learning".

Thus, for about two decades Computer Supported Collaborative Learning (CSCL) has been used effectively as a way to utilise the resources of an online community as a means to scaffold student learning [44]. CSCL provides an effective platform for both synchronous and asynchronous discussion and, as such, accommodates the time required for participants to reflect and then document reflections for input into discussions with others. Clarkson and Brook place emphasis upon peer collaboration using online forums and argue that ICT acts as a mediator in expanding the domain for cognitive development, or what Vygotsky [19] referred to as the "zone of proximal development" [40]. In promoting good practice in 'e-moderating' online discussions, Salmon advocates interventions such as 'weaving' discussion threads together to stimulate student engagement – such an activity, while not impossible without ICT, is one that ICT has made compellingly easy [45]. From an even broader perspective, Wenger *et al.,* have coined the term "technology stewardship" that incorporates the function of scaffolding in the wider context of the development and sustainability of online "communities of practice" [47]. In all these examples, interaction with others is prominent – and this approach has continued to gain momentum with the proliferation of Web 2.0 applications that foster online social engagement and collaboration. Moreover, as McLoughlin and Lee point out "Scaffolding need not be teacher directed, and current

social software tools can be used in ways that address learner centred concerns for self-managed learning and control (for example, e-portfolios)" [48].

In other approaches that are focused primarily on capabilities of the technology, Bell and Davis (2000) highlight the effectiveness of a guidance and prompting system as scaffolding for the development of scientific argumentation and general reflection [38]. Intelligent tutoring is also a field where the development of technological capability is of prime concern; however, as researchers involved in Project LISTEN at the Massachusetts Institute of Technology found a decade ago, the design of intelligent tutoring systems would be improved if they could augment cognitive support with "emotional scaffolding" [49].

#### 3.2.1 Automated Question Generation

While it is recognised that human tutoring still outperforms automated systems for progressing large units of study the development of intelligent tutoring systems (ITS) has progressed considerably since project LISTEN [50]. ITS have been used effectively in the development of reflective skills such as planning, questioning, explaining, and criticizing – primarily because they provide an effective means for practice [50, 51]. One area of research that is pertinent to this chapter is automated question generation (QG). In identifying a niche in which ITS might perform better than human tutors Graesser *et al.,* have observed:

> Most teachers, tutors, and student peers do not ask a high density of deep questions … so students have a limited exposure to high-quality inquiry. There are a few role models in school environments through which students can learn good question asking and answering skills vicariously. This situation presents a golden opportunity for turning to technology to help fill this gap. [51]

In earlier work, Graesser *et al.,* concluded:

> Training learners to ask deep questions (such as *why, why not, how, what-if, what-if-not*) is desired if we want the learner to acquire difficult scientific and technical material that taps causal mechanisms. The comparatively shallow questions (*who, what, when, where*) are often asked by students and instructors, but these shallow questions do not tap causal structures … [also] One of the key predictors of deep questions during inquiry is the existence of goals, tasks, or challenges that place someone in cognitive disequilibrium. Learners face cognitive disequilibrium when they encounter obstacles to goals, anomalies, contradictions, disputes, incompatibilities with prior knowledge, salient contrasts, obvious gaps in knowledge, and uncertainty in the face of decisions. [7]

Thus, one of the trends emerging from the QG community is the development of technology systems that do two things: (1) training learners how to construct good questions that promote deep reasoning skills; and (2) constructing well-formed questions from collections of content. This latter activity has significant implications for how ITS might be deployed for navigating explanatory content and represents a significant alternative to the keyword and key phrase-driven approach of the mainstream search engines.

To sum up: advances being made within the Question Generation community signal new opportunities for ICT-enable teaching and learning through the development of scaffolding that spans both the cognitive and the technical domains. It would also seem that some forms of scaffolding will always be better performed by humans (such as providing emotional support) while other forms will likely excel if embedded in the technology platform itself (including systems other than intelligent tutoring systems, such as learning management systems, electronic textbooks, e-portfolio systems, or Web 2.0 applications).

## 4. Cognitive Engagement

There exists an extensive body of literature on the subject of cognitive engagement from diverse fields such as anthropology, psychology, cognitive science, education, information systems, human-computer interaction, augmented cognition, and biometrics in marketing [52-58]. Much of it is grounded in scientific research. There is also a growing body of commentary concerned with the detrimental effects of the Internet on our abilities to stay focused – describing it as "the enemy of insight" [59], "the greatest detractor to serious thinking since television" [60], and an "ecosystem of interruption technologies" [61]. For Carr, one of the luminaries credited with first articulating the benefits and inevitability of "cloud computing", the Internet is:

> the single most mind-altering technology that has ever come into general use … when we go online, we enter an environment that promotes cursory reading, hurried and distracted thinking, and superficial learning … The Net's cacophony of stimuli short-circuits both conscious and unconscious thought, preventing our minds from thinking either deeply or creatively. [2]

A number of questions arise from this development: *does this situation represent a transitional condition or is it a warning that the consequences, yet to ripen, might be mass plagues of dementia?* And more pertinent to the theme of this book: *what does this mean for online learning?*

There are no simple answers, although the literature on cognitive engagement points to the fact that whether pedagogical techniques are used or not, interest and motivation of the individual learning are key factors. This is easy to say and not always easy to measure as motivation is multi-faceted and complex to understand [62, 63]. But as Corno

and Mandinach have shown, "self-regulated learning" represents the highest form of cognitive engagement in classroom contexts [55, 56]. So, amongst all the alerts and distractions of being online, it would seem that new tools and new scaffolding techniques will be required in order to optimise the opportunities for learning using ICT so that learners can better regulate their learning. Useful findings are already emerging from Question Generation research showing that students will perform better after being exposed to sessions of deep reasoning and that, contrary to expectation, exposure to text-based deep reasoning appears to provide better stimulus than spoken deep reasoning [64]. This finding probably points to the fact that text provides more opportunity for reflection. It is also consistent with observations in concerning the value of computer-mediated communication as it was first called in the mid-1990s [65].

Requirements for maintaining focus, as well as interest and motivation, have implications particularly for the design of purpose-built learning environments such as learning management systems, e-books, e-portfolios, virtual learning environments, and intelligent tutoring systems (in other words, platforms that are somehow *contained* within certain boundaries). In the case of *Second Life*, studies have shown that role-playing in immersive virtual environments can stimulate thinking, problem solving, and learning [53]. This is also true for standalone services, applications, and games that support learning, although in many cases they are already designed effectively to capture attention and, as Carr [2] argues are already calibrated for short attention spans.

It seems clear then, that the domain of (potential) cognitive engagement is both expanded and bombarded by the proliferation of innovations in ICT. A question that arises here is: *what are the boundaries of cognitive activity?* Drawing from both Anthropology and Cognitive Science Hutchins [66] argues that while common sense decrees that cognitive activities are considered to reside within an individual's head there are also "cognitive properties of a system". In this case, a system "comprises all the actors within a setting, their interactions with one another, and the technical and cultural tools they interact with." Following this, Crawford *et al.,* have developed a "framework [that] posits a holistic view of the classroom as a highly integrated system of actors, tools, and content engaged in individual and social learning activities over time [56]. There are many moments and circumstances in which cognitive engagement therefore takes place, some of which may not be online as such but may arise during another activity (such as reflection or planning) *as a consequence of being online*. Crawford *et al.,* therefore introduce the term *cognitive density* "to describe the aggregate level of students' (cognitive, social, and affective) engagement with learning materials and thinking, their progress in learning, their communication, and their use of time". However, their conclusion that "increasing cognitive density is a general approach to improving student learning and is independent of a specific pedagogic intervention" [56] appears to be at odds with the preceding discussion on the negative impact of excessive cognitive demands. One thing is clear – more research in this area is required if we are to successfully align emerging capabilities of ICT with optimised teaching and learning and in this process achieve better understanding.

## 5. Conclusions and future work

Innovation in ICT and the consequences that it brings to teaching and learning is not only relentless but it appears to be evolving at an increasing pace. While there is often an exciting and enabling upside with every new technological development and device there brings a new challenge – to better understand the consequences and implications, both positive and negative. The increasing prospects of major cyber-crime should be sobering enough.

Clearly, *inquiry* and *reflection* are key elements of learning. They need to be nurtured appropriately in the design of learning environments and in the conduct of teaching that align with contemporary realities. Cognitive engagement with ICT is much more than a question of attention span and is best conceived of as a crucible within which a rich mix of cognitive activities take place and from which new knowledge is created. If the rich information and one-click knowledge-sharing world is losing its balance through bloating and excessive interruption and search-and-distract behaviour then strategies need to be in place to re-balance it.

If "today's weirdness is tomorrow's reason why", as Hunter S. Thompson once famously quipped [67], then developing better tools to reason and understand *why* should be a smart move now.

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**Key Contributions of Paper 5**

This book chapter makes the following contributions to this thesis:

Firstly, it highlights a range of issues relevant to teaching and learning associated with developments in ICT and cognitive engagement.

Secondly, it investigates the relationship between questioning and learning and highlights the specific attributes of *why*-questioning – some of which are semantically-based, some are not.

Thirdly, it identifies the linguistic versatility of the word *why* and presents various ways in which *why*-questions may be classified.

Fourth, it places a focus on the intersection of questioning online and inquiry-based learning.

Fifth, it highlights contemporary developments in computational linguistics and automated question generation that relate directly to the computational challenges of handling *why*-questioning.

Sixth, it presents an historical account of the evolving ways in which *scaffolding* is used in educational discourse and situates *why*-questioning within a conceptual framework that identifies the general requirement of cognitive engagement where *why*-questioning is concerned.

Seventh, it shows that the domain of cognitive engagement is "both expanded and bombarded by the proliferation of innovations in ICT".

Finally, it points to a future where *why*-questioning can be supported and scaffolded by appropriate purpose-built innovation with ICT.

# Chapter 8: Scaffolding Reflective Inquiry: enabling *why*-questioning while e-learning

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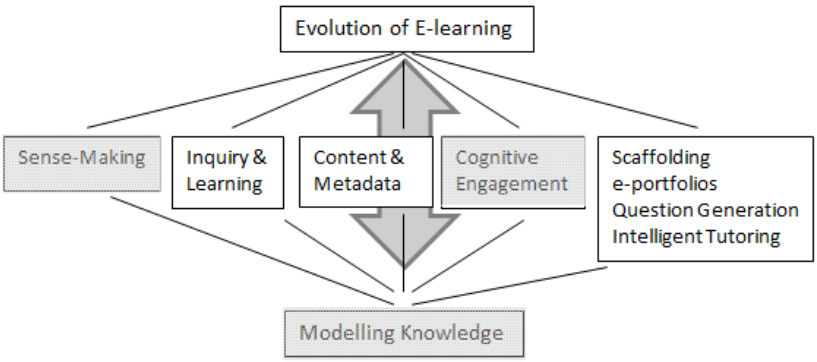


*Figure 8.1*. Topic focus of Chapter 8.

*Figure 8.1* is used here as a partial representation of *Figure 1.4*, highlighting the linkage between key topics within this paper – the evolution of e-learning, inquiry and learning, cognitive engagement, and scaffolding.

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# SCAFFOLDING REFLECTIVE INQUIRY – ENABLING *WHY*-QUESTIONING WHILE E-LEARNING

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This paper presents some theoretical and interdisciplinary perspectives that might inform the design and development of information and communications technology (ICT) tools to support reflective inquiry during e-learning. The role of *why*-questioning provides the focus of discussion and is guided by literature that spans critical thinking, inquiry-based and problem-based learning, storytelling, sense-making, and reflective practice, as well as knowledge management, information science, computational linguistics and automated question generation. It is argued that there exists broad scope for the development of ICT scaffolding targeted at supporting reflective inquiry during e-learning. Evidence suggests that wiki-based learning tasks, digital storytelling, and e-portfolio tools demonstrate the value of accommodating reflective practice and explanatory content in supporting learning; however, it is also argued that the scope for ICT tools that directly support *why*-questioning as a key aspect of reflective inquiry is a frontier ready for development.

*Keywords*: ICT; e-learning; pedagogy; critical thinking; explanation; reflection; question generation; question-answering; QG; Q-A; storytelling.

## 1. Introduction

### 1.1. *Purpose*

The purpose of this paper is to present some focused theoretical discussion on the importance of *why*-questioning during learning while also probing opportunities for ICT-based scaffolding that might support it. Tools that stimulate cognitive engagement and reflective inquiry are identified as providing an appropriate foundation. Historical and theoretical perspectives are introduced to establish context about the evolving theory and practice of e-learning and to underscore the significance of content or discourse that serves an *explanatory* function – in other words, information that is specific to the object of *why*-questioning.

### 1.2. *Scaffolding – an evolving concept*

Prior to the invention of the World Wide Web and the subsequent proliferation of information and communications technology (ICT) that supports learning, education, and training (LET), the concept of scaffolding was used to describe the support and guidance

provided by a teacher to a student to assist in conceptualizing problems and constructing knowledge. It was conceived initially with an "adult to child" emphasis (Vygotsky, 1978; Wood, Bruner, & Ross, 1976). It has now evolved in meaning to also include assistance provided by peer learners and ICT systems in the development of understanding and the construction of knowledge (Cohen, Manion, & Morrison, 2004; Foley, 1993, p. 101). In both meanings, scaffolding is therefore concerned with techniques and tools used to assist in the development and *maturation of understanding* associated with learning. Thus, the "process of scaffolding is much like the traditional definition of scaffolding as a temporary support system used until the task is complete and the building stands without support" (Lipscomb, Swanson, & West, 2004).

It follows from this simple characterization that once understanding or knowledge has been acquired, the scaffolding becomes redundant. However, the Web – or ICT innovation more broadly – has changed this. Through enabling diverse, user-friendly, personalized, novel and sophisticated devices, applications and services, ICT provides support for learning at many levels, including that of the user interface. As such, ICT itself provides scaffolding that may be used and re-used for multiple purposes. Search engines provide a generic example of this in supporting both *resource discovery* as well as targeted *information retrieval*. Numerous other innovations in search engine technology demonstrate a wide variety of scaffolding supports. For example, iBoogie (www.iboogie.com/) is a cluster search engine that organizes results according to conceptual categories that refine a search query, providing navigation cues through clustering of concepts and terms that are semantically related. In this case, the associated concepts and terms may inform the learner or information-seeker of the breadth of a conceptual domain not previously appreciated – thereby providing a useful scaffold. In a different approach, ManagedQ (www.managedq.com/) leverages Google results to queries adding to them a mix of visual cues while organizing results into sets associated with people, things, and places. In this example, visual and conceptual supports extend the domain of cognitive stimulus.

### 1.3. *ICT – enabling or interrupting?*

As a counterpoint perspective on enabling innovations in ICT, and particularly relevant to its application for LET purposes, commentary concerning negative cognitive impact of prolonged use has also begun to emerge in recent years. For example, instead of highlighting scaffolding functions, Carr (2010) characterizes IT as an "interruption technology" that weakens cognitive focus:

> The Internet … wasn't built by educators to optimize learning. It presents information not in a carefully balanced way but as a concentration-fragmenting mishmash. The Net is, by design, an interruption system, a machine geared for dividing attention … What we are experiencing is, in a metaphorical sense, a reversal of the early trajectory of civilization: we are

> evolving from being cultivators of personal knowledge to being hunters and gatherers in the electronic data forest. (Carr, 2010, p. 131)

Such a characterization may well describe some aspects of mainstream usage of the Web but it does not describe all usage scenarios, particularly those learning environments that are designed to contain interaction with specific content and peers. For example, the development of e-portfolio systems and use of wikis that specifically support reflective learning in both personalized and collaborative learning contexts represent important trends (Ajjan & Hartshorne, 2008; Alexander, 2006; Cambridge, 2009; Hallam et al., 2008; Loo, 2012). Intelligent tutoring systems and learning management systems represent other, more established, examples.

Building on these perspectives, the following discussion draws upon a wide body of literature that spans storytelling, sense-making, critical thinking, inquiry-based and problem-based learning, learning design, and reflective practice, as well as recent developments in knowledge management, computational linguistics and automated question generation. The question of *how might ICT be used to scaffold learning through supporting reflective inquiry and the probing of explanatory content* is a question that remains open throughout.

## 2. Interacting with Content Online

According to Oliver (2001), in a well-received paper at the time, there are three critical design elements for describing and developing online learning environments – learning tasks (activities), learning resources (content), and learning supports (scaffolds) (Oliver, 2001, p. 3). The relationships or interfaces between each element will vary according to situational context and also determine the effectiveness of such environments. Oliver demonstrates that this abstract model accommodates a wide variety of pedagogical approaches, all of which place varying degrees of emphasis upon different aspects of these elements. Thus, this model is adequate in describing pedagogy that gives emphasis to learning objectives while also accommodating inquiry-based learning in which the outcomes may not be prescribed. But while such models have high utility they can also mask complexity. For example, in the case of both inquiry-based and problem-based learning, questioning is a central activity that can function as both a task and a scaffold (depending upon who is asking the questions). Questioning also arises while sense-making, whether in dialog or during reflection. In some cases (such as a critical review of questions), questions may even function as the "content" or the focus of metacognitive skill development (Barell, 2010, p. 197; Gillies, Nichols, Burgh, & Haynes, 2012).

Developing a more descriptive model, however, is not the aim here. Instead, the following discussion is presented to highlight other key considerations that emerge when *why*-questioning plays a role within all three key design elements in Oliver's model. This is highlighted in the following discussion on primitive questions, storytelling, and the difference between information and explanation. Depending upon context, each of these can function prominently as constituents of *content, activity*, and *scaffolding*.

### 2.1. *Primitive questions*

Questions initiated by *who, what, when, where, why* and *how* belong to a set sometimes referred to as the journalists' questions (Urquhart & McIver, 2005, p. 82). Why this label? For the simple reason that answers to these questions help create a story. More importantly, without answers to *who, what, when,* or *where* there is no news and nothing to report. There are no facts, and there is no information. When answers to *who, what, when,* and *where* are supplemented with answers to *how* and *why* then the storytelling creates interest. When this happens, *information* is accompanied by a component of *explanation* – whether it is hypothetical, rhetorical, or otherwise.

These basic questions can also be considered in a number of other ways, depending upon function. Thus, some of these questions can be seen as functioning more as triggers for explanation (see Figure 1). From an information science perspective *who, what, when,* and *where* collectively form what can be termed the "primitives" of text-based information retrieval because they represent pivotal or "kernel" semantics in the retrieval and discovery of factual or "factoid" information (Evered, 2005; Kunze, 2001; Mason, 2008; Verberne, 2010, 2006). As such, they form the basis of most metadata schemas designed to identify, describe, and manage information resources, whether in physical libraries or in the digital domain. This is because they define the core aspects of provenance and the *aboutness* of content. This core function of factoid information is also important in calibrating how most search engines work – and therefore, has the consequence that most content that is sourced for learning via search engines is derived this same way. It certainly determines the kind of information processed by Google – ranking results according to hyperlink data might represent a profound innovation in search engine technology when first devised but it still essentially represents just another dimension of *aboutness* associated with the content – that is, data that can be objectively extracted from the content or content linked to it. Within the case of ManagedQ, a value-added service to Google search, results to queries are organized into sets associated with people (*who*), things (*what*), and places (*where*) – factual, or objective, information. Thus, while Google and other mainstream search engines might enable learning and knowledge sharing, their core technology function remains that of *information processing* calibrated for responding to *search terms* rather than *questions*. As such, the results displayed for Google queries are (so far) typically non-explanatory in nature – and, queries instigated

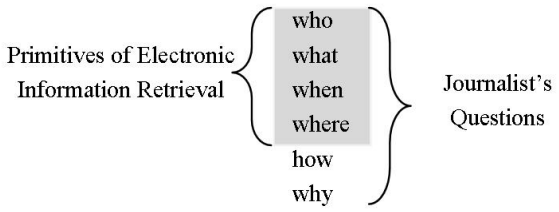


Figure 1. Core questions of information and explanation.

by *why* are therefore not accommodated in an optimum way. This is noteworthy because *why* is also a key question for reflective inquiry.

### 2.2. *Storytelling*

Storytelling, however, involves much more than information processing as it draws upon all available nuance and expressiveness that language has to offer. Importantly, the primitive questions discussed above can be seen as key components in the construction of stories.

> I keep six honest serving-men:
> (They taught me all I knew)
> Their names are What and Where and When
> And How and Why and Who
> (Kipling, 1902)

While stories of the form "*once upon a time in a far off land there was an ogre who lived under a bridge*", typically contain the four information primitives in the first sentence (who, what, when, and where), close analysis reveals other dimensions. For example, complexity is established as a result of there being a number of instances of *what* that can be discerned (the "land", the "ogre", the "bridge", as well as the sentence – itself a complete statement and therefore a "thing"). Anyone who has ever told such a story will also know that being interrupted by a young child with questions of *how* and *why* is part of the process of the child making sense of things, engaging their imagination, and deepening their comprehension. Implicit in the opening sentence above is also the fact that the *who* is also an actor who *did* things (such as living under a bridge and presumably many other things that can be imagined or are yet to be told). This latter dimension of storytelling aligns closely with Language Action Perspective (LAP), a theory aimed at informing and influencing Information Systems Development (ISD) (Flores & Ludlow, 1980; Lyytinen, 2004). LAP also places emphasis upon the "descriptive fallacy" (Austin, 1962) for ISD, a "misconception that language is used for descriptive purposes only" (Ågerfalk, 2003, p. 12). In other words, LAP argues that language is used to perform actions ("speech acts" such as orders, requests, recitals, explanations, oaths, etc.) as well as to convey meaning through information and communication.

As stories evolve they also typically contain other elements of content – such as conflict, desire, journey, transformation, a dramatic event, an issue that becomes complex upon detailed exposition, or an existential dilemma. The consequences and/or resolution to such elements typically require attention to the detail and unexpected turns within the narrative. Whether the listener or reader is emotionally engaged or objectively detached he or she is also invited to reflect along the way and make sense of the narrative. Thus, storytelling has been recognized as an important means of activating reflection, stimulating inquiry and, therefore, teaching and learning (Neal, 2002; Ohler, 2007; Schank, 2011). Of particular relevance here, Ohler further notes that "In education

[particularly problem-based learning], a quest story becomes a question story" (Ohler, 2007, p. 75). But more importantly to this paper is that stories typically contain (implicitly or explicitly) content that can be elaborated upon in response to a why-question.

### 2.2.1. *Storytelling, Knowledge Management and learning*

From a broad historical perspective, storytelling has its roots long before human societies became literate. In the case of Indigenous Australians, often through song, it has been a primary means of preserving cultural and environmental knowledge from one generation to the next for many thousands of years (Denning, 2001; Dunbar-Hall & Gibson, 2004; van den Berg, 2005). In functioning this way storytelling can be seen as a tool for teaching and learning and a forerunner or natural foundation for Knowledge Management (KM) – which is both an academic discourse and a managerial intervention focused on the value that knowledge and its management bring to contemporary economies (Mason, 2009). This link to KM is significant here because its own evolution provides a metaphor for the design and development of e-learning tools.

In recent decades storytelling has thus been recognized as an important tool for sense-making and knowledge sharing and, therefore, useful for KM (Denning, 2001, 2004; Snowden, 2002b). Since its explicit beginnings approximately two decades ago, KM has evolved from a managerial discourse driven by a theory of reduction (aimed at the "capture" of knowledge) toward a richer academic discourse and organizational intervention informed by complexity and theories of emergence (Nonaka & Takeuchi, 1995; Snowden, 2002a; Wierzbicki & Nakamori, 2006). Importantly, just like learning, KM involves much more than information management and requires conceptual tools that reach well beyond issues of provenance (*who, what, when,* and *where*) and the management of factual information. Building on the earlier work of Polanyi (1966) it is focused more on the interplay of tacit and explicit knowledge and facets of knowledge that also rely on *know-how* and *know-why*. As a consequence, a number of researchers have highlighted the intersection, or even convergence, of ICT systems supporting e-learning and KM (Anitha, 2010; Mason, 2005; Pedroni, 2007; Rosenberg, 2001).

The use of storytelling has also become prominent in recent decades within educational and sociological research. Stories are used as a means to collect qualitative data for what is now termed "narrative inquiry", an umbrella term that describes a range of rigorously defined and related research methodologies (Clandinin, 2007).

### 2.2.2. *Storytelling and rich media*

Following McLuhan's (1964) seminal work on the transformative impact of media upon culture, the evolution of ICT has clearly brought with it application of a rich diversity of media in teaching and learning while also expanding the depth and meaning of the term *content*. Just as search engines have developed rapidly to support efficient searching so too have the digital tools for storytelling. Prior to the invention of the Web the wordprocessor had already revolutionized the way that text could be created, manipulated,

and distributed. In the digital domain stories can now be told in many ways. Contemporary options now include blogs, wikis, YouTube, and social media in general. These developments not only provide new channels for digital storytelling but also signal expanding options for scaffolding learning (McLoughlin & Lee, 2009).

Thus, in the teaching of storyboarding for "new media", Ohler points out the critical function of narrative and that it "is often developed as a result of editing and reflection" (Ohler, 2007, p. 186). In other words, the construction of story – and by inference, conceptual coherence – develops as a consequence of reflection. For Ohler, in an ideal future:

> telling stories would be an important part of how we teach and learn. Storytelling would be appreciated as an effective way to combine academics, thoughtful reflection and analysis, emotional engagement, and active problem solving. (Ohler, 2007, p. 202)

### 2.2.3. *A bigger picture?*

In a similar way to Ohler, though expressed with bolder advocacy, Pink (2006) describes *story* as a fundamental human ability that requires mastering as we navigate our way from the "Information Age to the Conceptual Age" (Pink, 2006, p. 2). Story is an effective way of sharing and remembering information because it connects both our cognitive and emotive capacities – or, in Pink's terms, "story exists where high concept and high touch intersect" (Pink, 2006, p. 103).

Likewise, for Schank (2011) – one of the pioneers of modern Cognitive Science – the art of storytelling is a component of good teaching because it provides a key to engagement and stimulation of the "cognitive processes that underlie learning" (Schank, 2011, p. 45). He goes further by arguing that schooling needs to shift its focus from subject-based and test-based education to teaching these cognitive processes (Schank, 2011, p. 109).

Innovation in the application of ICT in teaching and learning will always be ahead of mainstream practice. The challenge that comes with evolving ICT capabilities is to sync teaching and learning practices with it. Conversely, through only applying conventional practice to the technology available, gaps in our understanding of how effective teaching and learning proceeds may be revealed.

Thus, it follows that storytelling has a role in scaffolding (whether ICT-enabled or not) and has wider application than that of occupying the minds of young children. An important feature of storytelling is that the same story can be told with many variations to the script (as in, for example, classical and contemporary versions of Romeo and Juliet). This feature can be seen as a metaphor for the variations in answers or solutions to complex or "ill-structured" problems in problem-based learning. As Barrell (2010) points out, "realistic, authentic problems – such as pollution of the planet or feeding the hungry – are so complex, messy, and intriguing that they do not lend themselves to a right or wrong answer" (Barrell, 2010, p. 178). This point provides an important perspective on what distinguishes explanation from information: its key role in the

development of comprehension and understanding. Following this it is proposed here that dedicated ICT tools that can facilitate the discovery of explanatory content would be very useful for both teaching and learning.

### 2.3. *Information and explanation*

While storytelling serves many functions and has demonstrated utility in teaching, learning, and research, the purpose of the foregoing discussion is to emphasise that stories need more than factual information to be engaging. Important to the theme of this paper is that a story can be both an object and an artifact of reflection. Perhaps even more importantly is that stories, or content within them, are useful instruments for stimulating and addressing *why*-questioning. In doing so, they draw upon explanatory content as well as descriptive information. For teaching and learning purposes stories represent a genre of content that can be targeted in developing ICT-enabled scaffolds that promote reflection. A key difference between information and explanation is that an explanation only needs to be *plausible*, not factual, for it to be understood. More importantly for learning, developing the ability to explain things is consistent with the development of reasoning skills.

Returning to the focus on *why*: more than any of the other primitive questions, *why* requires a plausible explanation or a rationale as an adequate response – in other words, information coupled with reasoning (Verberne, 2010, p. 10). Thus, *why*-questioning can initiate a shift from routine information processing to engagement of other cognitive functions, such as inquiry, analysis, problem-solving, and reflection. And while explanation and rationale are often part of a good story they are not necessarily its essential or driving components. Thus, in discovering opportunities for ICT-enabled scaffolding that might support reflective inquiry, it is the access to and production of *explanatory* content, as distinct from *descriptive* content, that is of prime interest. A promising research question that emerges is: *what ICT scaffolding innovations might be designed into systems explicitly built to support why-questioning?*

## 3. Reflection and Pedagogy

> Reflection is an important human activity in which people recapture their experience, think about it, mull it over and evaluate it. It is this working with the experience that is important in learning.
> (Boud, Keogh, & Walker 1985, p. 19)

From both philosophical and educational perspectives *reflection* is a cognitive activity that has an *object* (Bell, 1977; Ezio, 1987, p. 253; Kemmis, 1985). While that object could be broadly summed up as *experience* it also typically involves conceptualization itself – or thinking about thinking. In simpler terms, reflection describes considered thinking about *something*, and that something will at times be thinking itself. Depending upon context and circumstances, it will likely be a mix of complex cognitive processes involving recall, discernment, objectivity, identification of facts and issues, checking

assumptions, reconciliation, summarization, synthesis, and pattern recognition, etc. As such, it involves much more than comprehension or the composition of a journal entry – a common contemporary approach to evidencing learning in professional development contexts (Patrick et al., 2009). In situations that require domain-specific knowledge, reflection will also likely involve sophisticated cross-referencing with an established knowledge base (Wang, 2009).

While not all educational theories acknowledge reflection as important for learning most educational literature on the topic has appeared since constructivist theories of learning have emerged (Herrington, Herrington, Oliver, & Omari, 2000). However, Ryan and Ryan (2011) have recently observed:

> Despite the rhetoric around the importance of reflection for ongoing learning, there is scant literature on any systematic, developmental approach to teaching reflective learning across higher education programs/courses. Given that professional or academic reflection is not intuitive, and requires specific pedagogic intervention to do well, a program/course-wide approach is essential. (Ryan & Ryan, 2011)

In response to this situation an Australian Learning and Teaching Council (ALTC) project, Developing Reflective Approaches to Writing (DRAW), was initiated in 2010 with the aim of "developing a systematic, cross-faculty approach to teaching and assessing reflective writing in higher education" (Ryan & Ryan, 2012). Outcomes of this project include a number of successful pedagogical interventions or "teaching designs" that have been developed and tested. Prominent among these, and based upon earlier work of Bain, Ballantyne, Packer, and Mills (1999) involving "5Rs", is the "the 4Rs model of reflective thinking" (Ryan & Ryan, 2012). As its name suggests, this model identifies four key activities that can scaffold reflective thinking and are conceived of as a sequence that begins with reporting:

- Reporting (and Responding)
- Relating
- Reasoning
- Reconstructing

Because the DRAW project is focused on *assessment* of reflection as much as the *teaching* of it then its immediate consequence is upon pedagogy and not on implications for innovation in the design or implementation of ICT. The question that arises from this work in relation to the theme of this paper then, is: *how might the 4Rs model inform the design of e-learning systems and services?* Evidence indicates that implementers of e-portfolio systems for learning purposes already typically recognise the importance of reflection and accommodate it through the provision of designated spaces and tools within these systems – and, within systems already deployed there is activity that is consistent with the aims of the DRAW project (Cambridge, 2009; EAC, 2011; Hallam et

al., 2008). To date, however, the ICT tools themselves within these systems are geared toward facilitating the *documentation* of reflection rather than reflective activity or inquiry itself (Mason, 2011, p. 79).

There are other approaches to stimulating and supporting reflection, particularly in the context of inquiry, that are relevant to this paper (Casey & Bruce, 2011; Hoban, 2006; Land & Zembal-Saul, 2003). In research focused on scaffolding reflection on scientific explanations Land and Zembal-Saul (2003) found that "cycles of explanations" are typical of the learning process as "learners continually revisit and reflect on their understanding, they engage opportunities to revise and reassess what they know" (Land & Zembal-Saul, 2003, p. 65). This observation provides a useful link with *why*-questioning and has an interesting parallel in corporate settings where there also exists evidence of the importance of asking cycles of *why* questions in the quest to achieve better efficiencies. For example, there exists extensive documentation of the practical application of the *Five Why's* in improving efficiencies within the Toyota Motor Corporation (2003) and integration into recent applications of the *Six Sigma* method (iSixSigma, 2008). When confronted with new events within the workplace, particularly those of an adverse nature and not fully understood, staff are encouraged to pursue *why*-questioning to five levels to properly identify root causes.

Whether in contexts of formal learning or workplace performance reflection can therefore be seen as key to the development of explanatory and reasoning skills. Closely related to these skills are critical thinking and problem-solving – skills that have also been identified as foundational "21st century skills" in which *know-how* and *know-why* can be seen as pivotal (Barell, 2010, p. 175).

## 4. Critical Thinking, Reflective Practice and Integrated Reflection

While critical thinking and reflective practice can be defined in different terms (such as analysis and mindfulness) and there exists a significant body of literature associated with each, it is assumed here that they share much in common and both are generally understood as having positive influence upon learning. Neither activity takes place without some kind of critical attention or attitude of inquiry; in many situations they work together; and, *why*-questioning is common to both. The term "integrated reflection" is introduced here to place emphasis upon the range of cognitive activities that can take place during reflection. It is a term informed by the work of Schön (1987) and Wang (2009).

### 4.1. *Critical thinking*

Critical thinking involves cognitive processes often associated with inquiry and analysis and, within formal learning, education, and training contexts, the role of *why*-questioning has long been recognized as a key component in its development (Paul & Elder, 1999; Piaget, 1966; Wellman & Lagattuta, 2004). Inquiry-based learning is facilitated when the learner sets out to make sense of some content through interpretations, reflections, and judgments. Despite this, however, there does not appear to be one commonly accepted

theoretical approach to the conceptualization of critical thinking within the Philosophy of Education with ongoing debates concerning the roles of reason versus skill (Bailin, 1998; Seigel, 1990; Walters, 1994). In Psychology, the debate is to do with whether critical thinking is an aptitude or a skill (McPeck, 1994). Resolution of such debates is not crucial to the theme of this paper – what is important is how critical thinking might be facilitated. Traditionally, this will be understood to be the role of pedagogy; but with advances in ICT and learning design it is likely that purpose-built tools will also serve this role as scaffolding. But as yet, such specific tools have not been identified.

### 4.2. *Reflective practice*

In a similar way, the discourse on reflective practice and its epistemological roots reveals some tensions around "learning through doing" and "learning about" and the appropriateness and timing of reflection on the job (van Manen, 1995). But whether it is during internship or the context of continuing professional development it is now standard practice for practitioners (from professionals to trainees) to engage in a critical examination of outcomes of a learning experience. The mainstream institutionalization of this as an activity (such as keeping a personal journal) that takes place *after* a learning experience represents, however, only a subset of the potential range of cognitive tasks required for integrated reflection.

### 4.3. *Integrated reflection*

Schön (1987) has been credited with first using the term "reflective practice", defining it as "reflection-in-action" and as practice that involves "continuous learning" (Schön, 1987, p. 72). In this conception reflection can be seen as a process that is integral to a wide range of activities associated with learning – such as inquiry, communication, editing, analysis, synthesis and evaluation – and many more, depending upon context. This idea is consistent with the way that continuous professional development (CPD) and/or work-integrated learning (WIL) are implemented in many workplaces (Patrick et al., 2009). Scaffolding reflection-in-action has also gained attention in the development of online learning for at least a decade (Lai & Calandra, 2007; Lyons, 2010; Shannon, Roberts, & Woodbury, 2001; Sporer, Steinle, & Metscher, 2010).

More recently, Wang has proposed "an ontological model that specifies a generic organisational structure of eportfolios in the integrated reflection context" (Wang, 2009, p. 449). In this model, *reflection* features as a dominant ontological category within a structure that includes *learning subject*, *learning objectives*, *learning objects*, *assessment instruments*, and *reflection query*. Wang's conception of "integrated reflection" clearly has a pedagogical focus; however, his model is also explicit that reflection (or its evidence) represents much more than a collection of jottings or journalism after a learning experience and is facilitated by "active learning" (Wang, 2009, p. 455).

Thus, following both Schön and Wang, reflection represents activities far broader than reflective journalism – and *integrated reflection* indicates a range of cognitive activities beyond the recording of reflections, including discernment, critical thinking,

identification of facts and issues, checking, reconciliation, summarisation, synthesis, and pattern recognition, etc. (van Manen, 1995). As such, it represents a broad set of cognitive capacities that could be targeted by e-learning systems designers.

The challenge of achieving integrated (in-session) reflection, whether the session is a unit of e-learning or teaching or some other vocational activity, will ultimately be determined by the context. Where it is appropriate for scaffolding to assist in the process then the design of that scaffolding will be an important factor in determining the outcome.

Dedicated software focused on developing some of these capacities already exists that could be used effectively for e-learning – for example, Rationale™ is software designed specifically to enhance student abilities in forming rational arguments and reasoning skills through identifying fallacies or weakly formed arguments within existing texts. Its website contends:

> Rationale is the most effective software tool for building students' critical thinking skills. It can be used throughout all curriculum programs at tertiary, secondary and primary levels of education … [and] when someone states a contention, we usually ask "why?" Critical thinkers want to know the reasons for and against the contention before they form a judgment.
> (AusThink, 2009)

Combining the threads of the discussion above with that of the preceding discussion regarding primitive questions, Thomas and Brown (2011) identify and provide advocacy for the emergence of a "new culture of learning":

> We propose reversing the order of things. What if, for example, questions were more important than answers? What if the key to learning were not the application of techniques but their invention? What if students were asking questions about things that really mattered to them? (p. 81)

While it will always be important for learners to master the content of a particular discipline (Gardner, 2010, p. 28) the skills of critical thinking and problem solving gained through active questioning and inquiry are now recognised as just important, not only to employers but learners of the 21st century (Bellanca & Brandt, 2010, p. xvi-xxiii) and educators (Rothstein & Santana, 2011). Thomas and Brown's proposition clearly gives emphasis to inquiry and aligns neatly with recent advances in computational linguistics and automated question generation, both of which provide new opportunities for the design of tools to support e-learning discussed in the next section (Evered, 2005; Graesser, Rus, & Cai, 2007).

## 5. Linguistic and Computational Perspectives

### 5.1. *Linguistic versatility*

The versatility of the word *why* is clearly evident from the fact that it is commonly found in questions as well as a range of other linguistic expressions. From a grammatical perspective it can function as an interrogative (simply as *Why?*), an adverb (as in *Why do we sleep?*), as a pronoun (as in *There is no reason why she shouldn't attend*), as a noun (as in *He provided an analysis of the semantics associated with why*), and as an interjection (as in *Why, you're crazy!*). This versatility provides the basic rationale for why it might be useful to classify *why*-questioning (Graesser et al., 2007) prior to embarking on ICT systems design associated with supporting it. This linguistic versatility has the implication that any computational modeling of textual content that contains *why* will need to consider carefully the broader textual context because with linguistic versatility also comes ambiguity.

### 5.2. *Classification and automated question answering*

Evered (2005) provides an analysis in which the explanative function of responses to *why*-questioning is categorized according to three classes of explanation: Causal (*Why E? Because C* (C= cause)); Teleological (*Why E? In order to P* (P = Purpose)); and Gestaltic (*Why E? For these reasons, R* (R = Reasons)) (Evered, 2005, p. 201). For example:

Why did the city flood? *(Because of prolonged and heavy rain)*

Why did she attend driving lessons? *(In order to get her driver's license)*

Why has the Government introduced a new policy on digital copyright? *(There are a number of reasons, including the changing nature of the production, use, and access to content; the need for the legal world to keep pace with technological innovation; and, the rapidly evolving nature of digital content itself.)*

Closely aligned with this classification is the work of Verberne (2010) whose analysis on *why*-questioning is focused on linguistic structures and components that can inform the design of effective automated question-answering (QA) (Verberne, 2010, p. 17). Question-answering research has its beginnings in the field of information retrieval (IR) during the mid 1990s and now is associated with a significant and mature discourse (Maybury, 2002, pp. 8-11). Verberne's classification identifies four kinds of *why*-questioning after closer discourse analysis and "distinguish[es] the following subtypes of reason: cause, motivation, circumstance (which combines reason with conditionality), and purpose" (Verberne, 2010, p. 27). However, Verberne shows that while such classifications can be helpful they are not sufficient. Importantly, despite her expectation that algorithms focused upon reasoning would likely guide any effective automated answering system, her work on linguistic structure and relation reveals that "elaboration is more frequent as a relation between a *why*-question and its answer than reason or cause" – in other words, *explanatory content* can be seen as the object that *why*-questioning typically seeks. This key finding has helped Verberne develop a number of

related algorithms informed by IR and Natural Language Processing (NLP) techniques that together demonstrate an effective approach to ICT systems design for answering *why*-questioning (Verberne, 2010, p. 102). Despite achieving close to 60% effectiveness in answering *why* questions, Verberne concludes:

> high-performance question answering for *why*-questions is still a challenge. The main reason is that the knowledge sources that are currently available for NLP research are too limited to capture the text understanding power that is needed for recognizing the answer to an open-domain *why*-question. Since this capability is problematic for machines but very natural for human readers, the process of *why*-QA deserves renewed attention from the field of artificial intelligence. (Verberne, 2010, p. 140)

NLP has also been important in research and development of natural language search engines, such as PowerSet (http://en.wikipedia.org/wiki/Powerset_(company)) and TrueKnowledge (http://www.trueknowledge.com/). More recently IBM has led the DeepQA project with its smart computer named "Watson" (Ferrucci et al., 2010). This system uses a "massively parallel probabilistic evidence-based architecture for QA" that decomposes the complexity of the problem into a number of stages and tasks involving question analysis, hypothesis generation, hypothesis and evidence scoring, retrieval of relevant content, and ranking of candidate answers (Moschitti, Chu-Carrol, Patwardhan, Fan, & Riccardi, 2011). But again, there are limits to its effectiveness of answering *why*-questions:

> The expectation is that if there is a good explanation out there Watson can discover, score, and even chain levels of explanation together. However, inferring how and why answers that require deeper thinking may represent a level of intelligence that requires capturing knowledge that is much more difficult to automatically learn. (Ferrucci, 2011)

*Will these advances also deliver new opportunities for integrated reflection and inquiry instigated by why-questioning during learning?* Only time will provide an answer to this question for now; however, there is no reason why the design of ICT could not anticipate such developments given that innovation takes place in multiple domains in parallel. While such research and development activities are highly relevant to the central theme of this paper it is important to emphasise here that in developing ICT scaffolds for why-questioning the aim is not to find pathways to automated answers but to promote and support the inquiry process itself.

### 5.3. *Question generation*

Possibly one of the more promising areas of research currently underway yielding implementation opportunities for ICT tools that might support *why*-questioning is the

field of Question Generation (QG). As Thomas and Brown (2011) suggested above, and others argue (Barell, 2010; Freire & Faundez, 1989; Rothstein & Santana, 2011), it may well be that the framing of questions is more productive for learning in an information-rich context than the responses to them. Thus, Freire and Faundez also argue for the need for a "pedagogy of asking questions" that gives emphasis to the questioning process as something valuable in itself, where the answer may not even be relevant: "thinking about questions that may not always or immediately arrive to an answer are the roots of change" (Freire and Faundez, 1989, p. 37).

As one of the consequences of innovations in ICT, however, the volume of accessible information is at a scale never previously seen with information now being produced through increasingly diverse channels from increasingly many more sources and yielding potentially increasing layers of complexity (Benkler, 2006, p. 5). Thus, Graesser et al., (2008) make the following observation:

> For the first time in history, a person can ask a question on the web and receive answers in a few seconds. Twenty years ago it would take hours or weeks to receive answers to the same questions as a person hunted through documents in a library. In the future, electronic textbooks and information sources will be mainstream and they will be accompanied by sophisticated question asking and answering facilities. As a result, we believe that the Google generation is destined to have a much more inquisitive mind than the generations that relied on passive reading and libraries. The new technologies will radically transform how we think and behave. (Graesser et al., 2008)

Learning how to ask good questions is clearly very important in both teaching and learning. In highlighting this, the 1944 Nobel Laureate in Physics, Isidor Rabi, once responded to a question as to how he came to be a scientist, as follows:

> My mother made me a scientist without ever intending it. Every other Jewish mother in Brooklyn would ask her child after school, 'So? Did you learn anything today?' But not my mother. She always asked a different question, 'Izzy,' she would say, 'Did you ask a good question today?' That difference – asking good questions – made me a scientist. (Barell, 2008, p. 103)

Following this line of argument, Graesser, Ozum, and Sullins (2010), observe elsewhere that:

> Most teachers, tutors, and student peers do not ask a high density of deep questions … so students have a limited exposure to high-quality inquiry. There are a few role models in school environments through which students can learn good question asking and answering skills vicariously. This

> situation presents a golden opportunity for turning to technology to help fill this gap. (Graesser et al., 2010, p. 125)

Through developing intelligent tutoring systems and tools that can create well-formed questions from collections of relevant content it therefore seems likely that new opportunities are not far away for ICT that is better able to support *why*-questioning, and, as a result, support integrated reflection and deeper inquiry during e-learning.

## 6. Related Work

There are numerous examples of work that has some synergy with the theme of this paper. For example, the Inquiry Project at the University of Illinois is a project focused on the advocacy of inquiry-based learning and it uses the motto: "learning begins with questions" (Casey & Bruce, 2011, p. 77). Of course, no motto covers all scenarios and while learning can clearly take place without questioning – for example, through repetition and memorization – it is through questioning that reflection, discourse, and knowledge construction takes place.

In the area of e-portfolios used in learning, education, and training much has been said and documented about the key role that reflection can play in assisting ongoing learning and professional development (Hallam et al., 2008; JISC, 2008, 2010). An initial review of practice, however, reveals that while a designated space for documenting and collating personal reflections is a typical design feature of most e-portfolio systems very little exists in the way of tools that stimulate reflection, apart from question prompts and templates. Thus, apart from enabling personal journalism through blogs and template approaches to writing, scaffolding tools within e-portfolio systems that encourage the actual process of reflection still appear to be under-developed. The "ontological model [for] integrated reflection" specified by Wang (2009) and discussed earlier indicates a possible way forward.

Looking back to older theoretical models, Bloom's (1956) taxonomy of educational objectives provides an interesting reference point for the theme of this paper. Bloom's original framework identifies six levels of learning represented as a pyramid: knowledge, comprehension, application, analysis, synthesis, and evaluation – with the implication that each level of the pyramid represents a higher order or learning. In this conception, however, "knowledge" is only really a facet of knowledge (i.e. "knowing-*that*" and based upon knowledge of factual content). With comprehension as the next level (being able to describe and explain) it is interesting to note that *description* and *explanation* are conceived at the same level. At all subsequent levels knowing-*why* is a prerequisite. In many ways, while Bloom's taxonomy could be revised to be more relevant to current circumstances it also represents a model that presents the fundamental components of integrated reflection.

## 7. Conclusions

Theory and practice are mutually informing and co-evolve in multiple venues: the development of e-learning is no different and ever since the term was first coined in the late 1990s it has evolved as both an academic discourse and a broad range of practices. In tracking its evolution it is clear that multi-disciplinary and "transdisciplinary" research is required because it is typically involved in what has been termed "Mode 2 knowledge production" (Manathunga, Lant, & Mellick, 2006, p. 365). Such an approach is necessary in order to span the relevant inputs as well as to identify opportunities for future development. It is also arguably the case that the conceptual boundaries that define e-learning as an academic discipline are also emergent (Cooper, 2010). Given that *why*-questioning has been demonstrated as having an important role within learning then this emergent nature of conceptual boundaries is underscored by the related research and development underway within domains such as computational linguistics, knowledge management, inquiry-based learning, metadata for learning resources, e-portfolio systems, natural language processing, and automated question-generation.

This paper has drawn from a diverse domain of academic literature and been explicitly theoretical in pointing to opportunities for ICT innovation that could scaffold *why*-questioning and thereby support integrated reflection while learning. In particular, *explanatory content* has been highlighted as a key concern of *why*-questioning and a core component of storytelling. Significantly, it is identified as not well-supported by mainstream content discovery tools such as search engines.

It also appears to be the case that through better understanding of *reflection* and *reflective practice* during learning that new opportunities for scaffolding these activities using innovations in ICT will follow. Given that the skills of critical thinking and problem solving gained through active questioning and inquiry are now being increasingly recognised by both employers and educational researchers as essential applied learning skills for the 21st century (Dede, 2010, p. 55) then it may be that this latter agenda might drive the ICT innovation pointed to.

With the emphasis upon the role of questioning during learning within this paper, a number of questions are highlighted here as requiring further research:

(1) *What kinds of ICT tools might facilitate the discovery of explanatory content?*
(2) *What ICT scaffolding innovations might be designed into systems explicitly built to support why-questioning?*
*(3) How might advances in automated question-generation inform the development of ICT tools that might sustain deep inquiry?*
(4) *Will advances in ICT that supports natural language processing also deliver new opportunities for supporting why-questioning and integrated reflection during learning?*

These and related research questions arise from the fact that while mainstream search engines facilitate the discovery of content to enable learning and knowledge sharing, their core technology function remains that of *information processing* calibrated for

responding to *search terms* rather than *questions.* A consequence is that the discovery or retrieval of explanatory content is not an activity that is easily prescribed using these tools.

Finally, the following observation and question from Moor (2006) seems appropriate:

> There is a debate in the philosophy of science whether science *explains* nature or only *describes* it. Clearly, laws of nature are only descriptive. They describe by words or by mathematical equations the rules and order of nature. They give an answer to the question how things happen in nature, but they don't answer the question why things happen this way. This descriptive knowledge of nature is enough for any practical purpose, but curious creatures like us are not content with this kind of knowledge. We also want answers to the question *why*.
>
> The question "*why*" is about reason. Reason is not something that exists in nature, at least not in a way that we can perceive by our senses. Reason exists in our minds, in our thoughts. It is beyond the boundaries of our possible knowledge about nature. What tools do we have to deal with what lies beyond these boundaries? (Moor, 2006)

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**Key Contributions of Paper 6**

This journal article makes the following contributions to this thesis:

Firstly, it establishes theoretical perspective of the significance of *why*-questioning in learning – in particular, through inquiry and *integrated reflection* – while probing opportunities for ICT-based scaffolding that could support it.

Secondly, it presents theoretical perspectives on the design of ICT-based learning environments and raises questions about modelling that can mask complexity where questioning is considered as a key learning activity.

Thirdly, it highlights the prominent role of the "primitives of information retrieval" (*who, what, when,* and *where*) in organising and retrieving digital content while contrasting this role with two additional primitives (*why* and *how*) that are more concerned with *explanation* than *information* and instrumental in the development of reasoning skills.

Fourth, it situates the role of storytelling within teaching and learning, linking it to explanatory content.

Fifth, it highlights the significance of *plausibility* of an explanation during sense-making and in the construction of knowledge.

Sixth, it offers reflective commentary upon the sense-making function of pedagogical models such as Bloom's Taxonomy. While identifying the limitations of hierarchical representations this taxonomy makes explicit the foundational role of *knowing-why* in the development of understanding.

Seventh, it points to innovations within the field of automated question generation, suggesting scope for tools that "can create well-formed questions from

collections of relevant content". An example of the application of such tools may be in guiding the inquiry process (questions begetting questions) thereby supporting deeper learning more appropriately than the current dominant *search paradigm* in which questioning is abbreviated to sequences of keyword and key phrase searching.

Finally, it brings together into a single focus the topics of reflective practice, inquiry, scaffolding, and *why*-questioning.

# Chapter 9: The *Why* Dimension, Dialogic Inquiry, and Technology Supported Learning

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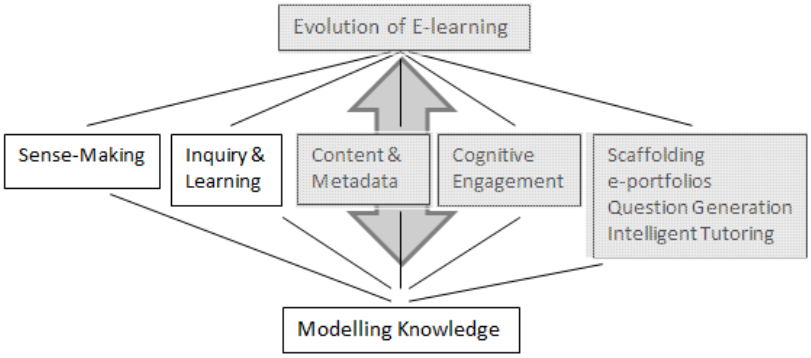


*Figure 9.1*. Topic focus of Chapter 9.

*Figure 9.1* is used here as a partial representation of *Figure 1.4*, highlighting the linkage between key topics within this paper – sense-making, inquiry and learning, and modelling knowledge.

# The *why* dimension, dialogic inquiry, and technology supported learning

Jon Mason

## Abstract

This chapter introduces a number of theoretical perspectives in presenting an analysis of why the *why dimension* of inquiry – *asking, learning, understanding, knowing,* and *explaining why* – presents challenges and opportunities for the design and implementation of technology supported learning environments. Central to this theoretical discussion are epistemological constructs such as 'becoming to know' (Jakubik 2011) and 'sense-making' (Dervin 1998; Weick 1995; Snowden 2002). Supporting this theoretical discussion is a number of sense-making models representing relationships between learning and knowledge and the characteristics of *why*-questioning. Reasoning, reflection, and dialogue are all identified as embedded within dialogic inquiry and these activities provide the context for consideration of how the *why dimension* in technology supported learning environments may be supported.

## 1. Introduction

This chapter can be read as beginning and ending with *inquiry*: it is intended to raise questions and stimulate discourse rather than serve as a commentary of closure. The underlying concern motivating its content is an investigation of *why*-questioning in technology supported learning environments. This concern is explored in terms of sense-making models that represent the relationships between learning and knowledge and the characteristics of *why*-questioning during inquiry. Dialogue is identified as a defining characteristic of inquiry initiated by *why*-questioning, although it is not the only one – activities involving reflection and reasoning are also prominent. In pursuing this topic

through research spanning a number of years numerous intersecting perspectives from diverse discourses have been drawn upon – discourses such as e-learning theory and practice, educational theory, information science, knowledge management, computational linguistics, communications theory, standards development, and anthropology. Intersecting discourses are nothing new to academic research; however, the consequences of developments in information and communications technology (ICT) since the invention of the Web can be seen as transformational for many domains of activity with ICT providing a common and convergent infrastructure. Such developments have few historical precedents. In many ways, in such a context, it makes more sense to embrace interdisciplinary perspectives than not.

As we move through the second decade of the twenty first century a number of trajectories are clearly evident in the ongoing development of technology supported learning environments. A dominant feature of the last decade has been social media in the mix of technologies that promote interaction, collaboration, networking, and knowledge sharing – at scales never before possible (Williams et al. 2011). Also prominent within a broadening discourse is the movement that has positioned itself to articulate what "21st century skills" might be; skills that place emphasis upon digital literacies, critical thinking, and problem solving in equal measure (Kuhlthau 2004; Griffin et al. 2012; Casey and Bruce 2011). There are strong drivers for an "open agenda" connecting various sub-movements that advocate open source software, open access, open learning, open data, and open educational resources (Leeson and Mason 2007). For some, data itself is the new currency – whether it is exposed, linked or linkable for research purposes, or part of a "data-driven" classroom (Mandinach and Jackson 2012). Mobile technologies are also making their mark in education, providing new opportunities for engagement in learning activities harnessing much more than convenience and personalisation through engaging interfaces that provide a sense of intimacy (Berge and Muilenburg 2013; Bruck and Rao 2013). For many practitioners the pace of innovation and

the growing options that involve technology devices have consequences on how we make sense of the world. And so it is that "sense-making" is a term that has entered the discourse on e-learning (Johnson et al. 2010). Through embracing this term and focusing on dialogic inquiry this chapter investigates how sense-making models might inform how ongoing technological innovation can support learning. Issues concerning semantics are raised; importantly, the rich ambiguity of the semantics of the simple one-word question "*why?*" Among its many functions this question provides a trigger for dialogue, a stimulus for reasoning, and a prompt for explanation or elaboration. While semantic ambiguity presents unique problems for information science and software engineering focused on data mining it also presents opportunities for innovative technology to support and stimulate reasoning skills and deep inquiry.

Through first focusing on inquiry itself, the following discussion provides an exposition of dialogic inquiry in the context of technology enabled learning. Issues concerning the nature of content are raised which introduces discussion on philosophical considerations concerning knowledge and how to represent it. A model is introduced to distinguish *explanation* from *information* and other models from cited literature are used to situate *sense-making* as a key activity in learning. The semantics of *why* are analysed from a linguistic perspective and five key activities – *asking, learning, understanding, knowing,* and *explaining* – are represented as the *why dimension* of inquiry and dialogue.

The chapter concludes with discussion of emerging innovations and opportunities for the design and implementation of technology supported learning environments that tackle the challenges associated with the *why dimension*.

## 2. Inquiry and learning

*Inquiry* takes place when an individual, group, or organisation set out to find out something – to satisfy curiosity, discover new information, acquire new knowledge, resolve a problem, or uncover the truth. Importantly, while *learning* may be a by-product or outcome, it is not necessarily the key focus as in the case of finding an answer to a question (Wells 2000, 62). Of course, for an educator where learning is the primary goal, supporting and cultivating student curiosity and inquiry represents good pedagogical practice from constructivist perspectives (Bruner 1966; Vygotsky 1978; Rothstein and Santana 2011). Importantly, inquiry is also very much a *process* that can involve a sequence of activities, as is represented in Figure 1 – an ideal representation of key activities that support inquiry-based learning.

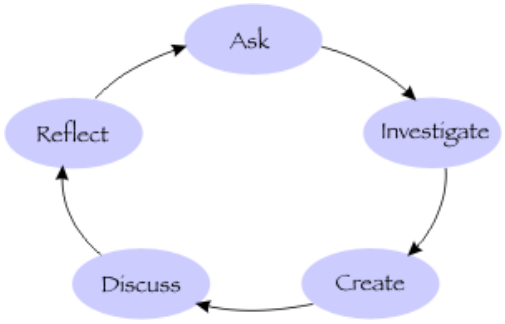


Figure 1: The Inquiry Cycle (Casey and Bruce 2011) – reproduced with permission

The Inquiry Project (2010) at the University of Illinois used Figure 1 in its advocacy for inquiry-based learning spanning a period of ten years together with a motto "learning begins with questions". In many situations this will be so, although Wells (2000) contends:

> Inquiry does not have to start with a clearly formulated question. In fact some of the most absorbing questions arise only after some preliminary work on the topic has been carried out, or as a by-product of trying to answer some other question. (62)

Thus, while representations such as Figure 1 can communicate a strong message they can also be seen to mask detail that may be relevant in specific cases. As such, inquiry is also

contextually bound as it may only involve a single act of investigation or reflection, the asking of a question, or even initiation of a technology supported search query. A virtuous circle of inquiry may take place but such a sequence is not a precondition for inquiry.

In her work on "Guided Inquiry", Kuhlthau (2007) describes a pedagogical approach that emphasises inquiry in which "five kinds of learning are accomplished […] information literacy, learning how to learn, curriculum content, literacy competence and social skills. An inquiry approach is a most efficient way to learn in the 21st century" (Kuhlthau 2009, 4). Underlying this focus is a model developed in earlier work (Kuhlthau 2004) called the Information Search Process (ISP). The ISP is also sequential in that it "describes thoughts, actions and feelings in six stages of inquiry: initiation, selection, exploration, formulation, collection, and presentation" (Kuhlthau 2009, 3). While this earlier (ISP) model is informed largely by *information* seeking a key characteristic of *Guided Inquiry* is relationships with others and, as such, it can be seen as a dialogic approach to learning.

However, and this is both a key argument and assumption of this chapter, while digital technology search tools may be powerful in processing information and enabling social networks they are also (currently) limited in terms of sustaining inquiry or even enabling inquiry that needs to probe deeper into reasoning, problem solving, and interacting with *explanatory* content. This is a significant constraint that exists with most mainstream Internet search tools primarily because they are configured to parse data and information that is calibrated from the *aboutness* of content – descriptive or identifiable information such as keywords and key phrases, date published, the author, and weightings associated with how many back hyperlinks can be determined. In other words, mainstream search engines can be seen as privileging "factoid" information that can be reduced to expressions of *who, what, when,* and *where* information (Verberne 2010; Mason 2008). Such information may satisfy basic information seeking and may even establish a basis for further investigation but it does

not necessarily stimulate reasoning, reflection, problem solving, critical thinking, and dialogue – all activities so fundamental to inquiry.

## 3. Dialogue, learning, and technology

The connection between dialogue and learning was most famously established by Socrates over twenty-five hundred years ago (Guthrie 1989, 723; Stumpf 1983). For Socrates, spoken dialogue was paramount in revealing poor argumentation and prejudice, particularly where ethical or moral issues were concerned. By encouraging the student as the protagonist of an argument the so-called *Socratic Method* places emphasis upon the instructor choosing probing questions that help guide or cultivate reasoning skills and a moral compass in the student. As Tokuhama-Espinosa (2011) observes, this dialectic and dialogic approach to learning not only has a proven track record but has currency in "prestigious law and medical institutions around the world, and … it is successful because it focuses more on the "*whys*" of information then the "*whats*" (Tokuhama-Espinosa 2011, 104 [*my emphasis*]).

In many ways contemporary educational literature on scaffolding (Teo 2003; Wood et al. 1976; Lipscomb et al. 2004) demonstrates a strong link with the Socratic approach. Likewise, the roots of the critical thinking movement in education can also be traced to Socrates, for its goals of clarity of thought and the pursuit of truth are similar, although the literature on critical thinking is more explicit about the importance of *metacognition*, or thinking about thinking (Paul 1990).

In technology enabled environments dialogue can be successfully achieved through a diversity of channels – from telephony and radio to an almost overwhelming array of options facilitated by social media. While the affordances of social media are said to characterise so-called *Web 2.0* (Rambe 2012) the scene for engagement in networked communications was already set prior to the invention of the Web with numerous electronic mail discussion lists

and Internet-based bulletin boards facilitating asynchronous text-based communications (Hart and Mason 1999). Looking beyond the current dominance of social media, however, a number of opportunities for innovation in technology supported learning environments arise – but these are discussed later in this chapter.

## 4. Dialogic inquiry

Probing the role of dialogue in learning from perhaps a deeper theoretical perspective Wells (1999, 2000) introduces the term *dialogic inquiry*, to highlight the central role that language has in meaning-making and learning. Drawing on the work of Bahktin (1981), Vygotsky (1978) and Halliday (1993), Wells presents an inter-disciplinary social constructivist theory of learning in which "linguistic discourse [mediates] … communicating and knowing right across the curriculum" (1999, 119). In doing so he also highlights the dialectic relationship between the individual and society that can be adequately addressed within a "community of inquiry" in which both teachers and students develop their understanding and knowledge (Wells 2000, 63). For Wells, this is made possible because language is learned by a child in interactions with his or her immediate community; in other words, because language is embedded in social activity it is naturally geared for dialogue, and "collaborative meaning making" (2000, 267).

Theory is, of course, always conceptual and likely to stimulate debate and further discourse – because concepts and their associated terms have meanings and meaning is typically contextual. For example, Wegerif (2008) suggests that "superficial resemblances between the ideas of Bakhtin and those of Vygotsky have led to *dialogic* being conflated with *dialectic*" (Wegerif 2008, 357 [*my emphasis*]) while Renshaw (2010, 1) puts an alternative case by highlighting the value arising from the intersection of these discourses. This is not the place to resolve such issues apart from noting that it is common for terminology found in one

discipline or discourse to be appropriated by another and when inter-disciplinary or cross-disciplinary discourse is pursued both collisions and confluence of meaning also occur. As such, no discipline or discourse ever really *owns* a term because natural language evolves. For example, in the Australian Macquarie Dictionary (2011) there are over eighty separate definitions for the common word "open": such as 'not shut, to disclose, an unobstructed space, to render accessible to knowledge, to cut or break into, to begin, to uncover' … etc. This common word has been used in recent decades by diverse communities of practice enjoying the benefits of the Internet but for different purposes, and with different meanings: *open learning* (independent, inquiry-based, and self-determined learning); *open systems* (systems with interfaces that enable interoperability); *open source* (shared intellectual input into the development of software with specific but royalty-free licensing requirements); *open access* (freely available academic research); and, *open educational resources* (content, digital tools, and standards developed for free public access and use) (Dewey 1916; Gasser 1991; Kelly et al. 2007; Leeson and Mason 2007). On this latter term, mathematically speaking, with over eighty differences in meaning for *open*, nine for *resource*, and with even only one for *educational* that would give in the order over 720 possibilities! But of course, human beings are able to parse semantics very efficiently enabling shared meanings (or assumed shared meanings) to be readily established in the course of dialogue. In short, natural language allows for or accommodates nuance of meaning and dialogue could not take place effectively without this intrinsic capability. Such flexibility of semantic function has also led to linguistic terms like 'semantic prosody' to be coined to describe the way certain words can be used to add further connotation in meaning (Sinclair 1991, 70-75; Hunston 2007).

Practice is somewhat more grounded than theory and recent literature reporting on the application of dialogic inquiry within the classroom suggests that while this interactive approach can demonstrably lead to greater student engagement, implementing it within

systems that default to monologic (invitation-response-feedback) pedagogic practice is not easily achieved (Lyle 2008; Warwick et al. 2011). Success stories also exist and in reporting on teacher participation in professional learning communities Nelson and Slavit (2007, 23) show that "dialogic inquiry grounded in classroom-based data is a key element in teachers' professional growth."

Importantly for the underlying theme of this chapter, Wells' conceptualisation of dialogic inquiry also raises issues concerning sense making and the construction of knowledge:

> If, as teachers and teacher educators, we hope to bring about significant improvements in the way in which the practice of education is enacted in school classrooms, an important first step … is to attempt to clarify our own understanding of what is involved in the construction and reconstruction of knowledge. (Wells 1999, 53)

This chapter is in part a response to this call; it also makes use of other conceptual constructs in order to point to the opportunities that can arise in the conceiving how dialogic inquiry might effectively be enabled in technology supported learning environments. The following discussion therefore introduces other key theoretical constructs of this chapter: *sense-making* and the notion of *question primitives*. Doing so involves the presentation of a number of models and the exposition of an epistemological approach adopted from the broad discourse on Knowledge Management (KM). As both an academic discourse and an organisational intervention KM is, after all, focused on *knowledge* – its creation and curation. This is also true of some branches of philosophical tradition (such as epistemology and gnoseology), which is where this discussion now turns in order to situate a key facet of knowledge and knowing – *knowing-why* – and its connection to *learning-why*. Why? In short, it is because among its numerous functions, the word *why* often serves as a trigger for both dialogue and inquiry.

## 5. Philosophical considerations

### *5.1 Epistemology, ontology, and paradigm*

As a branch of philosophy epistemology is concerned with such things as the nature, origins, components, and limitations of human knowledge – and it addresses questions such as *what is knowable* and *what is reality*. As such, it represents an open discourse that is investigative in character. Likewise, *ontology* is also a branch or philosophy but it is focused on the nature of being and experience; and, unlike epistemology, it is a term that has been appropriated by Computer Science to refer to a "formal, explicit specification of a shared conceptualization" (Gruber 1993) that functions as a relational, semantic taxonomy and is typically constrained to be domain specific. Ontologies are used in computer systems for the purpose of enabling semantic interoperability, enabling the discovery, aggregation, and exchange of content that is semantically related. However, both philosophical terms are also routinely used within educational and social research when framing methodologies and in declaring conceptual paradigms, as *positivist, critical, interpretive,* or as *naturalistic inquiry* (Patton 1990; Dash 1993). While much research can be classified according to these terms in practice much educational and social research adopts a mixed methods approach, often drawing from more than one paradigm with the aim of triangulating or validating findings. It could be argued, then, that much of this current discussion draws from critical, interpretive and naturalistic inquiry paradigms.

### *5.2 Changing paradigms*

The emergence and development of the technology enabled global information infrastructure over the last few decades represents nothing less than a profound re-configuration of social, economic, and technological structures with networks driving both innovation and disruption

(Benkler 2006). Such context therefore demands global perspective in grappling with what the dynamics and trends are. It invites inter-disciplinary thinking with many commentators either observing or arguing for "paradigm shifts" in the disciplinary discourses that prevail. As a prelude to this Bruner (1990, 4) observed that as part of the "cognitive revolution" and emergence of constructivist thinking, there was a shift taking place from the "*construction* of meaning" to "*processing* of information". More recently, Wierzbicki and Nakamori identify a change in paradigms from the *principle of reduction* to the *principle of emergence* as coincident with the beginnings of a "new informational knowledge civilization era" from around 1980 that they forecast will likely last around 120 years (Wierzbicki and Nakamori 2006, 1-13). In their book focused on knowledge creation they argue that:

> At the end of the 20th Century, together with the emergence of knowledge-based economy, the economic demand resulted in the need of a better understanding of creative processes, of micro-theories of knowledge and technology creation … we speak about a new scientific revolution that concentrates on the understanding of detailed mechanisms of creative processes, needed today and tomorrow for knowledge economy and informational society. (Wierzbicki and Nakamori 2006, 6)

How does this manifest in the education sector? In 2013 within the Graduate Programs at the University of British Columbia, for example, a subject called *Creating Technology Enhanced Learning Environments* is offered and described as follows:

> Paradigm shifts in education have influenced significant change in learning environments. This course is an inquiry into learning environments (past, present, and future) and explores the learning theories, software, hardware, and instructional strategies that support them. (University of British Columbia 2013)

In fact, it is commonplace within the broad discourse associated with digital learning to find *changing paradigms* being referred to. An example is the emergence of the so-called 'flipped classroom' – a term that has caught on in recent years to describe the removal of instructional lectures from the classroom, with students instead being asked to make use of Internet based content at home focused on a particular topic prior to engaging in discussion and problem solving activities in the classroom (Tucker 2012). The assumption here is that in many cases students can discover content equally as informative as what an instructor might initially provide. But the innovation goes deeper in that it also promotes inquiry-based learning followed by dialogue and collaborative activity. This may represent a paradigm shift in terms of practice but it is also consistent with a social constructivist approach to teaching and learning.

*5.3 Becoming to know*

The work of Jakubik (2011) on the "knowledge creation paradigm" within the broader Knowledge Management discourse represents an important contribution beyond the discourse community for which it is targeted. Jakubik presents a "becoming epistemology" and a "becoming to know framework" with a conceptualisation at its core that emphasises a virtuous cycle (or spiral) involving learning, knowing, and becoming (See Figure 2). As an epistemology, it moves beyond propositional statements toward a theory of actualisation.

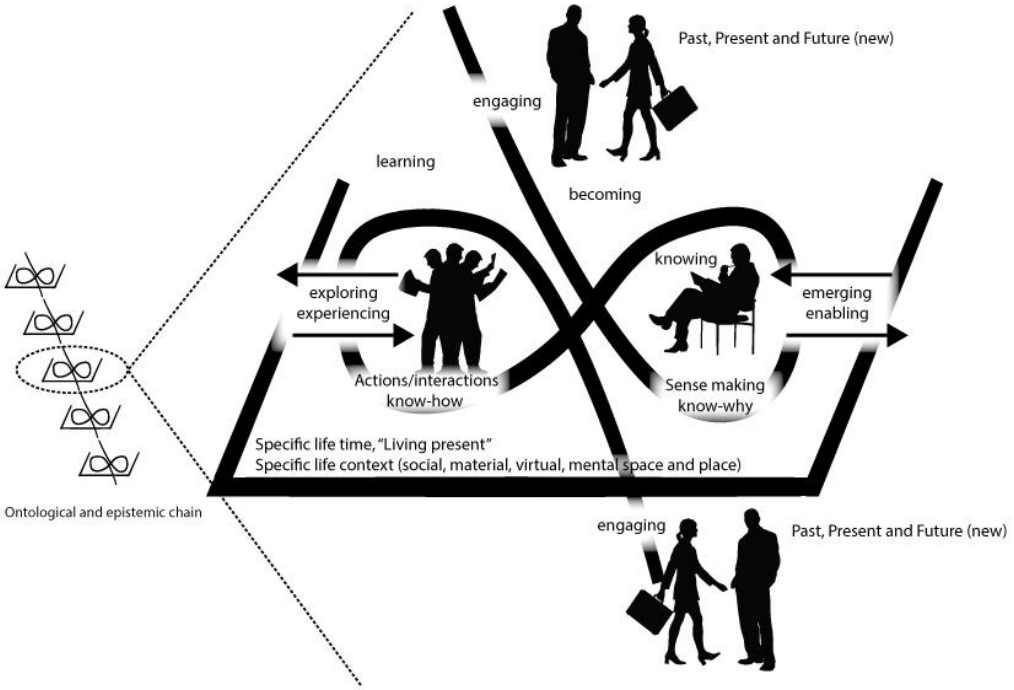


Figure 2: Becoming to Know. Adapted from Jakubik (2011, 381)

For Jakubik:

> Becoming … is viewed not only as evolution, change, a dynamic and emerging process, but as a dialectic and iterative process of continuous experiencing, learning and sense making. ‘‘Becoming epistemology’’ is both an engagement (actions and interactions) with the real world in a living present and making sense of the experience. It is a movement or flow from the past toward the future through the living present. Because both reality and humans evolve (i.e. are being changed) and because the learner (subject) and what it is to learn (object) are in unity, there is a dynamic and dialectic interplay between learning and knowing … ‘‘becoming epistemology’’ is a synthesis of learning and knowing … (Jakubik 2011, 392)

Key to Jakubik’s framework is *engagement*, a shared context for knowledge creation where activities such as dialogue are instrumental. In explaining the semantics embedded in her conceptualisation Jakubik makes use of the philosophical term *phronesis*, a term associated

with the application of wisdom in clearly identifying *ends* and discerning the best *means* to achieve them. This term is described by Nonaka et al., the originators of Knowledge Management as a distinct discourse, as a "forgotten kind of knowledge … practical wisdom" (Nonaka and Takeuchi 2011, 58). In Jakubik's conceptual framework it is certainly not forgotten, as it has a key function in connecting *know-why* and *sense-making* with *know-how* (see Figure 2).

So why is *know-why* important here? For Jakubik (2011, 389) becoming has a teleological dimension, one of three primary explanatory functions of *why*-questioning as outlined by Evered's (2005) "typology of explicative models":

> Causal: (*Why E? Because C* (C= cause));
> Teleological: (*Why E? In order to P* (P = Purpose)); and
> Gestaltic: (*Why E? For these reasons, R* (R = Reasons))

There are other reasons why *know-why* is important and to elucidate further the discussion now turns to what distinguishes *explanation* from *information* and the implications this has for technology supported learning environments.

## 6. Questions and inquiry

Questions initiated by *who, what, when, where, why* and *how* belong to a set sometimes referred to as the journalists' questions (Urquhart and McIver 2005, 82). Why this label? For the simple reason that answers to these questions help create or frame a story. More importantly, without answers to *who, what, when,* or *where* – the most basic facets of factual information – there is no news and nothing to report. As it happens, these four key questions also comprise the core semantics of all metadata schemas – that is, schemas used particularly by librarians to identify, organise and classify information for structured purposes of

information retrieval and resource discovery, particularly on the Internet (Mason 2009). Together, responses to these four basic questions also define the core aspects of provenance and the *aboutness* of content – in other words, the descriptive dimension of content. Whether the *what* is a description of the content, a keyword, kind of resource, or even weighting information about the number of hyperlinks associated with it, this still refers to the aboutness of content. For these reasons the four basic questions have been described as the "primitives of information retrieval" (Mason 2008, 547) or as the "kernel" of Dublin Core metadata (Kunze 2001). However, when answers to questions of *who, what, when,* and *where* are supplemented with answers to *how* and *why* then storytelling takes place and information is accompanied by explanation or elaboration – whether it is hypothetical, rhetorical, truthful, or otherwise (see Figure 3).

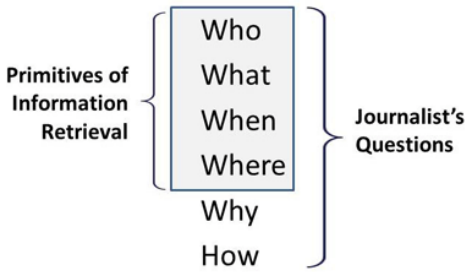


Figure 3: Question Primitives of Information and Explanation

At this point it seems natural to ask the question why *why* and *how* not part of the core set of primitives for information retrieval, when in conversation they can certainly elicit information as a response. Put simply, the main reason is that the semantics of *why* and *how* as standalone terms do not carry sufficient context to map clearly to factual information and are either ambiguous (*why* having causal, teleological, or gestaltic implications) or relate to procedural knowledge, as with *how* (Mason 2009; Verberne 2010). In the case of a *why*-question, what is typically expected in response is either some kind of rationale or plausible explanation – as such, the response just needs to satisfy the conventions of dialogue which

are often concerned with achieving a sense of *shared meaning*. In this function *why*-questioning is an act of inquiry that seeks to make sense or understand – information is not its core concern. Because of this search engines do not currently respond effectively to *why*-questions, as contextual information is difficult to infer from a single *why*-question. This presents a challenge for designers of tools that might help learners interact directly with explanatory content and suggests that a dialogic approach might guide such development.

In terms of teaching practice that puts student questioning and inquiry at the forefront of learning, Rothstein and Santana (2011) outline the Question Formulation Technique, an approach to collaborative learning in which divergent thinking (through opening the mind to new possibilities), convergent thinking (involving synthesis, analysis and meaning making), and metacognition (reflection upon these processes) are all brought together in a structured sequence (Rothstein and Santana 2011, 16-20). In this technique students are encouraged to ask their own questions and in class activity learn to classify different question types and to appreciate the difference between open and closed questions. After many years of applying this technique results show:

> Students who learn the difference between closed- and open-ended questions climb a sharp learning curve in a very small amount of time. We have seen in many settings that it is a transformative moment when the student discovers and truly understands this one important lesson: *the construction and phrasing of a question shapes the kind of information you can expect to receive*. (Rothstein and Santana, 2011:74)

Questioning not only drives dialogue it is also an important aspect of learning and a powerful tool when it is the student who constructs questions for further inquiry. When these questions touch upon the need for explanation or elaboration – that is, something more than information – then *sense-making* is stimulated. Likewise, storytelling invokes sense-making beyond the

communication of factual information. And one reason why storytelling is a powerful means of knowledge preservation and sharing, as is evidenced by pre-literate Indigenous cultures, is that it situates information within a context broader than that described by *who, what, when,* and *where*; it connects with experience, an *epistemology of becoming,* and the necessity to continually make sense of the world.

## 7. Sense-Making

Among the many cognitive activities that can take place while learning *making sense of things*, or *sense-making*, is integral to comprehension and the development of understanding. Whether this act is interpretive or reflective it can also be understood as conducive to the creation of knowledge (Weed 2003, 143). While it is not necessarily a component of all learning or knowledge creation, as in the case of rote learning, it plays a particularly important role during inquiry, taking place at any time from initiation to culmination of an inquiry, or during reflection once inquiry has ceased.

*Sense-Making* can also be seen as terminology with high utility as it has been used as a formal methodology in recent years in academic discourses such as Communications (Dervin 1998), and a key term within Management (Weick 1995), Complexity (Snowden 2002), and Information Systems (Sharma 2010). There are differences in approach and detail but essentially:

> The concept of sensemaking is well named because, literally, it means the making of sense. Active agents construct sensible, sensable … events … They 'structure the unknown' … How they construct what they construct, why, and with what effects are the central questions for people interested in sensemaking … [importantly] Sensemaking is grounded in both individual and social activity. (Weick 1995, 4-6)

Whether it takes place as a single cognitive act or a series of cognitive acts, *sense-making* involves more than eliciting *meaning* from communication or content and the construction of knowledge based upon that meaning. Sense-making also involves *comprehension* and *understanding*, both essential components of learning and achieving these may require abstraction and/or construction of models that express relationships and processes (Bloom 1956; Anderson and Krathwohl 2001; Krathwohl 2002). To make sense of things is to find or perceive a certain coherence in things; a pattern of relations, causes and effects; to *understand why* actions or events have taken place; or, to discern natural phenomena or social conventions. For Wells, however, there is an added dimension when sense-making takes place within dialogic inquiry: "[I]t is by attempting to make sense with and for others, that we make sense for ourselves" (Wells 2000, 57).

Importantly, sense-making may also invoke "sense un-making" because constructing knowledge may involve the dismantling of a former conceptualisation (Dervin 1999, 729); or, it may also represent conditions of *stasis*, where plateaus of understanding function, inquiry pauses, and conceptualisation of the world has sufficient coherence. Thus, for most people, the concept of gravity can be readily understood in the way Newton understood it – it makes sense as a *law* of the natural world, and apples do predictably fall from trees. However, it is also the case that for fewer numbers of people the sophisticated conceptualisations of physicists like Einstein and Hawking can be readily understood. While it may make sense to accept the judgement of the scientific community actually understanding the science is another thing altogether. Thus, while scientific method and thought may point to deeper, discoverable truths, grounded in evidence, scientific discourse also contains many competing theoretical models that both describe and explain the way things are. To be useful, then, theories and models just need to be plausible in order to make sense. If something makes sense, then sufficient understanding is enabled allowing new concepts and knowledge to be

created. A metaphor for this process can be found in standards development, in which a standard can be understood as a stable document representing consensus from a community of practice. Standards are only ever developed to completion when two conditions are met – they are fit for purpose*;* and, they have gained sufficient consensus for adoption. In other words, they make sense in having utility for a defined constituency and a specific purpose. The question now emerges as to how to best make sense of the *why dimension – asking, learning, understanding, knowing,* and *explaining why* – so that components within technical specifications such as data models, information models, and ontologies can be created to inform development of digital technologies to support learning. One approach is to consider existing models.

*7.1 Knowledge modelling*

The use of models and frameworks to represent conceptual domains and enable the development of shared conceptualisations are proven devices to stimulate sense-making. Whether expressed as a simple taxonomy or classification, a table, an entity-relationship model, computational code representing rules for interactions within a domain, or as a complex data model for an IT specification, knowledge modelling takes place within many discourses and communities of practice – including Anthropology (Wilkins 2013, 5), Educational Theory (Bloom 1956; Krathwohl 2002), and Knowledge Management (Nonaka et al. 1995; Snowden 2002). Take for example the *wisdom pyramid* as depicted in Figure 4.

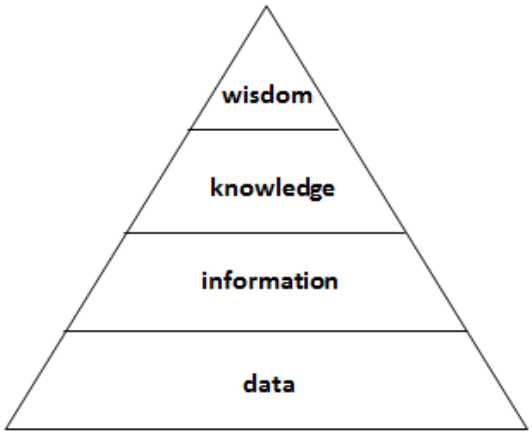


Figure 4: Data-Information-Knowledge-Wisdom (DIKW) Pyramid

The wisdom pyramid (also known as the DIKW pyramid) depicts a simple hierarchical relationship between data, information, knowledge and wisdom. As such, it can readily make sense and has utility when conveying that the higher conceptual entities within it are supported by those beneath. It also implicitly involves a progression from no context (data) to the development of meaning, understanding, and insight. Combined with syntax and semantics, data becomes information; as information is contextualised and interpreted it becomes knowledge; and as knowledge is tempered with experience it can become wisdom.

Despite the simplicity of the DIKW model it has attracted much attention and debate. Detailed study of the literature reveals a broad use of semantics, with the conceptual boundaries between *knowledge* and *information* where most divergence exists (Cleveland 1982; Adler 1986; Zeleny 1987; Ackoff 1989; Hey 2004) and variance in where to situate concepts like *understanding*. For example, Zeleny (1987, 60) represents the hierarchy as a progression from "know-nothing" (data) to "know-why" (wisdom) while Ackoff (2009) represents a progression of deepening understanding from *relations* (data into information) to *patterns* (information into knowledge) to *principles* (knowledge into wisdom). Others have probed this broad usage and identified insufficient treatment of wisdom (Rowley 2007) or provided critiques (Mason 2003; 2009; Frické 2009; Sharma 2010) that point to inadequacy

of the model to inform ICT systems development, because it is not an accurate representation for all contexts and rendering knowledge into data where possible is also a value-chain that is commonly pursued. Following this, it can be argued that the cliché of the *knowledge age* describing our times has already morphed into the *data age*, because data is now seen as the higher value entity in which knowledge is perceived more as latent.

Probably the biggest weakness of the wisdom hierarchy as an adequate model of knowledge is that it lacks explicit representation of movement or dynamics as does the epistemological framework of Jakubik shown in Figure 2. In the conceptual modelling of Snowden (2002, 110) knowledge is far more complex because it is "both a thing and a flow". This same point is taken up by Dervin (1998, 36), a prominent exponent of "Sense Making methodology", when she conceptualizes "knowledge and information as a verb". *Verbing* concepts to account for the dynamics of learning can be also seen in Krathwohl's (2002) revision of Bloom's taxonomy of educational objectives, shown in Table 1, in which each term is reworked into active tense in the same sense of *becoming*. It is also notable in Krathwohl's revision that *knowledge* as a key term has been removed, partly due to the fact that in Bloom's usage factual knowledge (*knowing-that*) is not a complete representation of knowledge. For Krathwohl, knowledge can be classified into four kinds: factual, conceptual, procedural, and metacognitive (Krathwohl 2002, 214).

| Higher Order Thinking | |
|---|---|
| Bloom's Original Taxonomy (1956) | Revised Taxonomy (Krathwohl 2002) |
| Evaluation | Creating |
| Synthesis | Evaluating |
| Analysis | Analyzing |
| Application | Applying |
| Comprehension | Understanding |
| Knowledge | Remembering |
| Lower Order Thinking | |

Table 1: Bloom's Taxonomy – original and revised

Bloom's taxonomy has made sense to educators for over fifty years. It continues to do so – particularly in its revised form and when grounded within discipline-specific subject matter – as teachers endeavour to teach in ways that develop higher order thinking skills. But, again, just like a standard, it is a model that has utility within a defined scope of application and it is not intended to mean that all cognitive activity associated with learning must begin with remembering factual information in order to understand it or that teaching factual knowledge is a prerequisite to enabling any creative knowledge construction. It is, however, not immediately clear where *why dimension* might be situated within the taxonomy although *explaining* can be an aspect of understanding, *asking* an aspect of analysing, and *knowing* an aspect of evaluating. From an inquiry-based learning perspective, it is also arguable that such taxonomies are at odds with representations such as the Inquiry Cycle (Figure 1) in which inquiry does not necessarily depend upon subject knowledge to proceed. Such dissonance does not render either approach as wrong but it points to limitations in the application of these models. So, what other representations might be of use?

The use of spirals to represent interactions of tacit and explicit dimensions of knowledge has been used following Polyani's (1967) work within the philosophy of science highlighting the tacit dimension in which he famously stated "we can know more than we can tell". Much of the discourse on knowledge management initiated by Nonaka and Takeuchi in 1995 draws upon Polyani in proposing a dynamic model that represents the organisational knowledge lifecycle as interactions of tacit and explicit knowledge throughout four ongoing processes involving socialisation, externalisation, combination, and internalisation known as the "SECI model". Within this model dialogue plays a key role in the externalisation of tacit knowledge as aspects of it become explicit. This approach to modelling is common within the KM literature and is also present in Jakubik's epistemological framework. Moreover, it aligns well with Wells' treatment of dialogic inquiry:

> The understanding attained through knowledge building dialogue at the end of one cycle provides the basis for *making sense* of further experience and information in the next. This is one of the senses in which there is a *spiral of knowing* over successive engagements with the object of the activity which the knowing serves to mediate. (Wells 2000, 70 [*my emphasis*])

Because this chapter has been concerned with inquiry, questions of how to harmonise these and other approaches to knowledge modelling are left lingering – although a synthesis relevant to inquiry is proposed in Figure 5, where a relationship between reflective and dialogic activity is depicted within processes of asking, learning, understanding, knowing, and explaining why. While reflection has not been dealt with in any detail within this chapter and dealt with elsewhere (Mason 2012) Figure 5 is intended to emphasise its relationship to dialogue, with reason connecting both. In some ways, as already argued, such models are adequate in whatever context they make sense; while the lingering questions are also questions that need to be pursued further if new ICT tools are to be developed from rigorously produced conceptualisation and modelling.

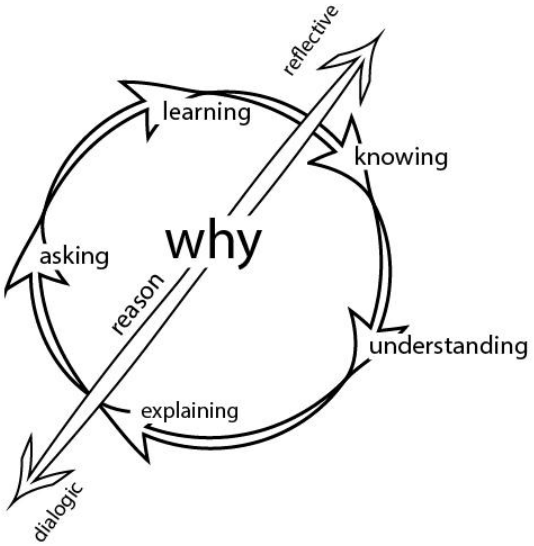


Figure 5: The Why Dimension of Inquiry

*7.2 Tools for sense-making – tools for inquiry*

In technology supported learning environments sense-making is stimulated by many things: text, symbols, graphics, animations, video, navigational design, questions, and engagement or dialogue with others. In recent commentary that reaches a large constituency of educational professionals (the annual *Horizon Report* published by the New Media Consortium), sense-making has been appropriated as an important term within the discourse on e-learning:

> The abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators in sense-making, coaching, and credentialing. (Johnson et al. 2010, 3)

Part of this challenge involves development of critical thinking skills in this context of abundant information resources and networked opportunities for social and professional engagement. But is also invokes a call for the development of inquiry skills (Kuhlthau et al. 2007) and use of dialogue in the development of reasoning skills (Ravenscroft 2007; 2011). In order to maximise the advantage of the richly networked environment of the Internet skills are required beyond point-and-click searching or browsing the vast information spaces and socially connecting with others; skills that require discernment, engagement, reasoning, dialogue and inquiry.

So, what will the tools be within technology supported environments that might stimulate this? In sum, the tools useful for sense-making will need to interoperate well with the tools of inquiry. Existing tools include social media and collaborative workspaces such as wikis that promote reflective writing and social engagement; they also include intelligent tutoring environments that utilise discourse technologies (Gholson et al. 2012; Graesser 2011) and application-specific games (Ravenscroft 2007). Dialogue is part and parcel of such tools; however, these tools can also be seen as in the early stages of development in that they do not

provide explicit or sophisticated support for dialogic inquiry initiated by *why*-questioning – or any other explicit support for the *why dimension*.

A number of promising frontiers useful for supporting the *why dimension* of inquiry – and, in particular, dialogic inquiry – are already emerging. These include automated question-generation, a field that has arisen out of the intelligent tutoring community, and is focused on building systems that can create questions appropriate for any content and enable students to be scaffolded in the construction of well-formed questions. Thus, Graesser et al., observe, that in traditional classroom settings:

> Most teachers, tutors, and student peers do not ask a high density of deep questions … so students have a limited exposure to high-quality inquiry. There are a few role models in school environments through which students can learn good question asking and answering skills vicariously. This situation presents a golden opportunity for turning to technology to help fill this gap. (Graesser et al. 2010, 125)

## 8. Conclusion

Through focusing on dialogic inquiry and how it manifests in technology supported learning this chapter has introduced the *why dimension* as a construct that represents dialogic and reflective inquiry across a continuum of activities. A variety of sense-making models have also been introduced which highlight the role of the *why dimension* in contexts that involve both learning and knowing. Specifically, Figure 2 highlights *knowing-why* within a 'becoming to know' epistemological framework; Figure 3 distinguishes between information and explanation; and, Figure 5 represents a set of key activities of the *why dimension* – *asking, learning, understanding, knowing,* and *explaining why*.

Within any learning context the *why dimension* represents activities that are either foundational or integral to inquiry – and therefore this construct can be seen to function as a sense-making model that might also inform the design of technology supported learning. There are limits to what models can express, however, and while they are important to sense-making their utility is defined by context. Reasoning, reflection, and dialogue are all activities associated with dialogic inquiry and these activities provide the context for consideration of how the *why dimension* in technology supported learning environments may be supported.

While there exists an abundance of digital technology that can be harnessed for purposes of inquiry and learning it is the mainstream *search* tools that maintain a dominant role due to their high utility. But, as powerful as they are for purposes of data mining, information seeking, and enriching social networks, they remain limited in their capacity for sustaining inquiry that needs to probe deeper into reasoning, problem solving, and interacting with *explanatory* content. Whether it is through the agency of social media, intelligent tutoring, or some other innovation in digital technology, technology support of a dialogic approach to inquiry holds much promise.

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**Key Contributions of Paper 7**

This book chapter makes the following contributions to this thesis:

Firstly, the *why dimension* is most explicitly introduced in this paper as a theoretical construct and sense-making model.

Secondly, in contrast to all preceding papers, *dialogic inquiry* is represented as an alternative pathway to reflective forms of inquiry that have been given prominence in earlier papers.

Thirdly, it introduces epistemological constructs such as Jakubik's (2011) *becoming to know* that inform both sense-making and knowledge modelling and in which represent both reflection and dialogue.

Fourth, it situates the development of the *why dimension* within historical and philosophical (epistemological, ontological, and paradigmatic) contexts.

Fifth, relationships between dialogue, learning, and digital technology are highlighted.

Sixth, it unpacks the conceptual foundations of *sense-making* and situates this construct within the discourse on e-learning.

Seventh, whether enabled by models, dialogue, or any other input sense-making is shown to be determined by context.

Finally, the concept of "tools useful for sense-making" is introduced as a frontier for digital technology innovation. In Chapter 10, this is re-phrased as the construct *sense-making technologies*.

# Chapter 10: Reflections, Findings and Conclusions

This concluding chapter draws together contributions made by thesis through first reviewing the purpose of the study as a reference point in connecting all preceding discussion with further commentary on the *why dimension.* This additional commentary is partly in response to identification of similar terminology used within recent literature from within educational psychology (Alexander et al., 2009; Geary, 2009); it is also in part a series of further reflections upon the *why dimension* and other core constructs used throughout this thesis. Following this are some reflections upon the dimensions of knowledge and the scope of sense-making. Due to the iterative nature of inquiry there have been numerous findings associated with the production of this thesis. A summary of the pivotal findings is included. Finally, a summary of the contributions made by this thesis is made explicit.

## Reflections upon purpose

As outlined in Chapter 1, "the overarching purpose of this study consolidated as a theoretical investigation into the existing and potential role of digital technology support for the *why dimension* in e-learning" (p. 12).

The collection of papers serves this purpose and vindicates the multi-disciplinary approach taken. Together, these papers represent a broad conceptual reach that has been necessary in order to adequately deal with the focus of the investigation. In terms of method and outcome the chosen topic provides emphasis upon *inquiry,* establishing close links with *why*-questioning while also leaving open possible and plausible futures. Thus, as is stated in Paper 7, "this chapter can be read

as beginning and ending with *inquiry*: it is intended to raise questions and stimulate discourse rather than serve as a commentary of closure" (p. 155).

It is also useful here to be reminded of the two research questions outlined in Chapter 1:

1. *Why does the convergent ICT infrastructure provide no explicit technology support for 'knowing why' in knowledge management and 'asking why' in e-learning?*
2. *Would modelling knowledge with a transdisciplinary approach inform how 'why-questioning' might be supported during e-learning?*

This thesis has offered a number of explanations to these questions throughout. Following further reflection and dialogue, some further commentary is now provided.

**Commentary on the core construct**

While the *why dimension* appears most explicitly in Paper 7 it is represented primarily in terms of a theoretical construct and abstract sense-making model. An additional summary of the key aspects of each of the five activities associated with the *why dimension* can be conceived as follows:

- *Asking why:* is concerned with sense-making and seeking explanations
- *Learning why*: invokes reasoning skills
- *Understanding why:* constructs plausible conceptualisations
- *Knowing why:* rationalises plausible conceptualisations
- *Explaining why:* enables dialogue and story; elaborates upon plausibility

Conceiving of these activities across reflective and dialogic contexts (as in *Figure 2.6*) provides a checklist of functions that can be considered in both the technical and pedagogical design of e-learning. Without consideration of the *why*

*dimension* then content is something that is more easily reducible to just an informational function.

In the development of this thesis the *why dimension* has emerged as a core construct with origins in a sense-making model (*Figure 2.1*) and early conceptions that involved connecting *why*-questioning with knowing-*why*. This initial conception is also articulated within the first stated research question in which the interdisciplinary nature of the study was stated as involving the fields of e-learning (*asking why*) and knowledge management (*knowing why*). As a more complete construct the *why dimension* is now presented as a conceptual tool that can inform the discourse on e-learning beyond just *asking* and *knowing* why.

Like all constructs the *why dimension* draws upon concepts and associated terms in a unique way and for a specific context; however, this does not mean that a similarly termed construct cannot be formed from a different conceptualisation – and this is precisely the case with the *why dimension* and a motivating reason for the inclusion of this commentary here.

Subsequent to developing this construct for the purposes of this thesis, continued review of the literature has revealed that Geary (2009) used identical terminology in offering a critique of Alexander et al., (2009) who developed a four dimensional theoretical framework for the primary purpose of accommodating multiple theories of learning. This framework moves beyond the debates of competing theories of learning toward a presentation of multiple perspectives by beginning with the focus question *'what is learning anyway?'* (2009, p. 176). What is of direct interest here is that the four dimensions are labelled as *who, what, when,* and *where*.

For Geary, the framework developed by Alexander et al.:

> … is in need of a fifth, *why* dimension. The *why* dimension helps to place learning within an evolutionary and cultural perspective and to better understand students' motivation to learn and their preferences for what, where, and how to learn. (p. 198)

On closer analysis of both these positions there can be seen conceptualisations using the terms *who, what, when, where, how,* and *why* in a very different manner to that used in this thesis. For Geary and Alexander et al. the conceptualisation of the dimensions of learning has a different function and involves different semantics. Thus, Geary concludes:

> Incorporating a *why* dimension into Alexander et al.'s framework will allow us to better understanding why students prefer some methods of learning (e.g., in peer groups) over others (e.g., worksheet practice), their motivation or lack thereof for engaging in some forms of learning, and will help us to better situate the where (classrooms vs. peer groups) and when (e.g., based on dictates of a multigrade curriculum) of learning historically and cross-culturally. (p. 200)

In both Geary's and Alexander et al.'s conceptualisations neither the four dimensions describing *what* learning is, nor the *why* dimension, indicate anything to do with processes of inquiry and are used more as a means of providing an explanation for the efficacy of some learning theories over others in different contexts. As noted in both Paper 5 (p. 93) and Paper 7 (p. 8) this is a consequence of the versatility of natural language. This observation is salutary and can be seen as a vindication for the presentation of the role of sense-making within this thesis. It also highlights the fragile semantic base of some constructs.

**Reflections on the dimensions of knowledge**

The contribution of novel knowledge by an individual to the broader community is a latent potential of every human being. The question as to what constitutes novel knowledge, however, is deeply philosophical: thus, the contributions of Professor Stephen Hawking to 'our' understanding of astrophysics and the knowledge of a street beggar in Mumbai are of a different order. The contribution of the former is accepted (although contested) by the broader scientific community due largely to the profound mathematics used to express it; the contribution of the street beggar, however, has probably not yet been expressed to a larger audience. *Why?* Is it not possible that the street beggar may have an existential insight, some *know-how* – some novel knowledge – that could contribute to the benefit of humankind? It would be contrary to science to answer *no* without investigating. In academic contexts, however, another consideration also concerns the *value* of the contribution – for example, while a computer programmer and a computer hacker may both make contributions to how computer code functions the latter's contribution is typically not valued. While epistemological debates will and should continue about such matters the critical point of difference in these examples is the knowledge that is articulated, the context in which it is situated, tested against evidence, and valued.

As discussed in Chapter 2, a constraint on the efficacy of early modelling of the facets of learning and knowing is due to its circular representation. In terms of the epistemological framework, *'becoming to know'* adapted from Jakubik (2011) and represented in *Figure 1*.5, further refinement of this model could be undertaken to better express movement through time as *becoming*. This is significant in that the *why dimension* indicates activity or enactment – not just information nor procedure

nor rules. Nonetheless, it is also worth making explicit the close correspondence between the core of the initial *sense-making model* of thinking, learning, and knowing in *Figure 2.1* (see *Figure 10.1*) with the core of the *becoming to know* epistemology of *Figure 1.5* (see *Figure 10.2*).


*Figure 10.1.* Conceptual core of early proposed sense-making model


*Figure 10.2.* Conceptual core of the epistemic and ontological chain (Jakubik, 2011)

The claim to have made a significant contribution to a discourse community – in terms of new knowledge – is a claim that must likewise be examined against the evidence. And yet, there is not one answer as it will and should be contestable; for discourse is documented, dialogic, and emergent. Knowledge has been implied to be multi-dimensional throughout this thesis; the quest for *knowing* is also a quest of *becoming* as there is a dimension of time and enactment that determines or shapes knowledge. And so it is through considering the *why dimension* in the context of digital learning that this thesis shows that *knowing why* represents a facet of

knowledge not only worth knowing but one that is instrumental in the cultivation of reasoning skills through reflection and dialogue in teaching and learning.

**Reflections on sense-making**

Baudrillard (1988) made the observation that "we live in a universe where there is more and more information and less and less meaning" (p. 95). Such a characterisation could be seen as consistent with the term "informational" used in Castells' (1996) seminal work that identifies prominent sociological properties that are characteristic in the "rise of the network society". Baudrillard's observation can also evoke a need to make sense of this emergent situation – and one conclusion, pointed to in this thesis, is that with less *meaning-making* a consequence may be a clearer role for *sense-making*. *Sense-making* has been a pivotal construct throughout this thesis and while it has been defined *in situ* within each of the papers as well as in the terminology section of this thesis some further commentary is warranted for a number of reasons.

Firstly, this construct is distinguished from *meaning-making*, an important construct in the literature associated with constructivism and "meaning-centered education" (Kovbasyuk & Blessinger, 2013; Jones & Brader-Araje, 2002; Hein, 1999; Jonassen et al., 1995). *Why* is this distinction made? In many contexts it would seem that these terms could be used interchangeably – for example, in understanding how to respond when driving a car and approaching a red light: making sense of this situation and understanding the meaning of a red light are one and the same. In situations involving more complexity, such as discerning the intent of statutory legislation concerning the pricing of carbon, to make sense of the documentation requires reasoning while the meaning of such a document might simply be

understood as a mechanism to ameliorate climate change. Another example more pertinent to this thesis is in the use of abstract models as a means of communication required for expressing more complexity than the semiotics of a conventionally accepted symbol, such as an exit sign. To understand the full implications of a model may require extended reflection and reasoning while the meaning of such a model may just be that it is an abstract representation or it may develop over time. Thus, meaning is not necessarily ascribed in the process(es) of sense-making nor essential to it. Another reason for the distinction is that making sense of things has utility as a turn of phrase (just as *common sense* has) while finding meaning in something is somewhat more problematic and can raise issues of semantics and philosophy (such as vexed questions concerning the meaning of life). Thus, in the *Oxford Companion to the Mind*, Tiles (1987, p. 450-454) observes that "(t)he concept of meaning is every bit as problematic as the concept of mind." But probably the most relevant reason for this distinction is that the object that *why*-questioning seeks is not so much concerned with any meaning that can be inferred from *information*, but more with gaining *understanding* of the *explanation* or rationale that might typically form a response (Mason, 2012b, p. 178-182). Meaning may still arise, but it is something that would take place as secondary to sense-making. Thus it is that questions of the form '*what* does something *mean*?' are very telling: there is *semantic proximity* in such common expressions between '*what'* and '*mean'* because both words are related to *aboutness*; conversely, it is the *semantic ambiguity* of *why* that requires sense-making. As the following question-response demonstrates, it can be challenging to actually ascribe *meaning* in a *why*-question or in its response:

*Question:* Why can't fundamentalists and relativists resolve their differences?

*Response*: Because fundamentally a relativist's position does not seem definite;

while relatively speaking a fundamentalist does not compromise.

While the *meaning* of the question in this question-response example may not be ambiguous the response can plausibly mean either a play on words that does not properly answer the issue, or a serious attempt to convey conundrums associated with semantics. If someone is genuinely interested in this question then the 'meaning' could also be that further investigation or debate is needed. Thus it can be seen than meaning in this example is subjective and contextual. Importantly, meaning is of a secondary consequence or even no consequence to the question itself when conundrums are involved.

Secondly, while *Figure 2.6* is used to represent the '*why dimension* of inquiry' it is not made explicit in any of the papers that the five core activities associated with the *why dimension – asking, learning, understanding, knowing,* and *explaining* – can also be understood as *sense-making* activities that could be applied to other primitive questions (such as *how* and *if*).

Thirdly, the finding from the papers contained in this thesis that the semantic ambiguity associated with *why* presents challenges for semantic technologies suggests a role for another emergent construct, *sense-making technologies*, that might be plausibly developed and deployed in ways that utilise representational capabilities for communications and learning beyond semantics (such as simulations, animations, and prolonged inquiry sessions).

Finally, *sense-making* can be seen as a construct that can also inform the design of technology useful for learning. This is because there is an important sense-making function to conceptual modelling, a recognised stage in design processes that

leads to technical specifications for technological development – so much so that formal languages such as Unified Modelling Language (UML) have been developed for this purpose.

**Summary of pivotal findings**

Numerous findings have emerged in the development of this thesis and the papers within it. The following list identifies those that have been pivotal; however, it is indicative only and not intended to represent an exhaustive account of each moment in conceptual development.

1. The semantics associated with the word *why* are typically ambiguous – this is confirmed from anthropological studies of linguistics in which this ambiguity disqualifies *why* from being classified as a "semantic prime" (Goddard & Wierzbicka, 2007).
2. *Why* is a word of broad linguistic and conceptual versatility and instrumental in sense-making, inquiry, reasoning, and dialogue.
3. *Why* is associated with five key activities that span reflection and dialogue – asking, learning, understanding, knowing, and explaining.
4. The semantic ambiguity of *why* presents significant challenges for the development of computer systems that interface with natural language.
5. Curated digital content is typically supported by standardized metadata schemas which are reducible to a core set of "primitive questions" (*who, what, when,* and *where*) that together enable the retrieval and discovery of factual information (Kunze, 2001). *Why* is currently absent from such schemas due to its semantic ambiguity, although there is no impediment to the inclusion of explicitly defined facets of *why* (such as rationale and purpose).
6. *Why*-questioning typically seeks explanation as distinct from information.
7. *Why*-questioning is associated with prolonged or deep inquiry that is not currently well-supported by mainstream search engines.

8. Advances in computational linguistics and natural language processing are not yet sufficiently robust to accurately automate all commonplace variations of *why*-questioning (Verberne, 2010).
9. The *why dimension* is associated with explanatory content that may also invoke story and knowledge sharing.
10. Sense-making does not depend upon semantics.
11. Sense-making can intersect with meaning-making but involves processes (such as reasoning, pattern recognition, and episodic memory) that do not necessitate the construction of meaning (Tulving, 1985; Goldberg, 2005).
12. Developments in the fields of automated question-generation and intelligent tutoring point to ways in which *why*-questioning might be better scaffolded in contexts involving technology enhanced learning (Graesser, et al., 2008; 2010).

## Contributions to the discourse

The following discussion summarises the contributions made to the discourse on digital learning in terms of both theoretical constructs and other outputs.

### Theoretical and representational constructs

A number of conceptual and representational constructs have been developed in the production of papers for this thesis as well as in the introductory sections for purposes of conceptual clarification and synthesis. These include the introduction of the notion of *primitive questions*, linking them to facets of knowing and learning; providing a distinction between *information* from *explanation* within content; identification of *explanative* content as being associated with *knowing-why;* advancement of the case for the value in defining metadata schemas that can provide an *explanatory* as well as a *descriptive* function (through supporting short statements of rational or purpose); identification of a need for specification of metadata schemas that would assist in the retrieval of explanatory content; identification of issues

associated with representations of knowledge in terms of *data, information*, and *knowledge*; the distinction made between *meaning-making* and *sense-making*; introduction of the *why dimension* across a continuum of reasoning that is dialogic in one direction and reflective in another; positioning of the *why dimension* in a manner that aligns with the discourse on 21st century skills and extends the contribution on "guided inquiry" by Kuhlthau (2007); representation of reflective and dialogic inquiry as alternate pathways to deeper inquiry through cognitive engagement; introducing the construct *sense-making technologies* as a plausible genre of technological development that can be distinguished from *semantic technologies*; and positioning of the *why dimension* within a broader discourse that can be understood as consistent with the *open agenda* in education.

**Other outputs**

This thesis has also pointed toward a broad scope for the development of digital technology tools that directly support *why*-questioning through reflective and dialogic inquiry ranging across learning environments that utilise e-portfolios for self-directed reflective learning, wikis for socially reflective learning, and intelligent tutoring tools such as automated question generation. Such tools could establish alternative paradigms for how inquiry might be conducted using digital technology – that is, 'alternative' to the dominant search paradigm that privileges retrieval of informational content.

The notion of *plausibility* of an explanation as a sufficient condition for the development of understanding while learning also provides an important contribution to understanding the construction of knowledge. Plausibility is conceived in terms that give emphasis to conceptual coherence and rational argument and is contrasted with factual or incontestable information and knowledge. *Sense-making* shares with

*plausibility* in explanations a function that assists in the construction of knowledge, knowledge that may be superseded by new knowledge.

Finally, because the multimedia-rich environment of digital technologies shifts the weighting from the primacy of text as the driver of discourse (and the reliance therefore upon rigorously defined conceptualisations and semantics) toward multiple channels of sense-making then *sense-making technologies* will likely occupy a new frontier of development supporting digital learning – in particular, digital learning that makes use of deep inquiry.

**Further Research**

This thesis has proposed significant and emergent scope for innovation with digital technology that may enrich learning experiences through supporting deeper inquiry facilitated by focused reference to the *why dimension*. There are also consequences that point to further research and a prominent example emerges when re-considering the sense-making model proposed in *Figure 2.1*. In this model, *why* is the only primitive question with properties of ambiguous semantics. This then begs a question: *is it the ambiguous semantics associated with* why *that drives inquiry (through reflection and dialogue to achieve disambiguation); or, is it that* why *is associated with other aspects of sense-making that drive thinking, impact learning, and therefore invite further investigation?* Such questions arise in consideration of advances in the fields of cognitive neuropsychology and cognitive neuroscience in which distinctions are made between semantic and episodic memory as neuronal foundations for both procedural and declarative knowledge (Tulving, 1985; Goldberg, 2005, p. 132). While both procedural and declarative knowledge can be *represented* with semantics and logic – as outlined in Chapter 6 – the episodic

function can be seen as not necessarily dependent upon semantics. This is significant in the context of this thesis for two reasons. Firstly, the episodic function of memory is understood within cognitive neuropsychology and cognitive neuroscience as foundational to learning because it is based upon processes of pattern recognition that embrace both routine and novelty (Goldberg, 2005, p. 194-199). Secondly, the notion of *episodic* is similarly foundational to storytelling which has been shown to play a prominent role in cultural stewardship and contemporary knowledge management techniques (as discussed in Chapter 8).

As outlined in Chapter 6 there exists scope for the specification of metadata schemas that might accommodate statements of rationale or purpose – in other words, key linguistic facets of *why*. Development of such schemas is a project that would be aligned as a practical outcome of the findings in this thesis.

Theoretically, while the knowledge modelling within this thesis has been interdisciplinary it could be further informed by conceptualisations from the sociology of knowledge (Bijker, Hughes, Pinch, & Douglas, 2012).

However, limitations of the current findings are also evident – a prominent example to emerge during the examination of this thesis is that further analysis is required that connects specific teaching and learning strategies characteristic of inquiry-based learning to the *why dimension*.

With the *why dimension* currently conceived as functioning across a spectrum involving both reflective and dialogic practice then it follows that a range of digital tools can be developed and deployed that specifically support these activities. Research that focuses on *how* these tools could be used effectively is needed in order to build upon the conceptual findings.

From current trends identified in *Figure 2.2* a number of likely future trajectories in the evolution of digital learning will have connections with findings in this thesis, beyond inquiry-based learning. For example, the broad uptake of social media provides ongoing stimulus and innovation in the use of diverse collaborative environments at scales unprecedented; and, with the change in millennium the idea of "21st century skills" has emerged as construct more relevant than content knowledge in which priority skills for learning are framed around digital literacies, critical thinking, and problem solving in equal measure. Other developments will emerge as a consequence of ubiquitous broadband connectivity, innovations in natural language search technologies, access to larger collections and diverse forms of open educational resources (including 'open' inquiry tools), proliferation of mobile technologies, mainstreaming of work integrated learning programs, and innovation with intelligent tutoring systems. As the discourse develops debates also arise, such as whether 'IT' develops further as an "intelligent technology" or an "interruption technology" but in all these domains there is scope for development of digital tools that support the *why dimension*. It follows, that further research within all these domains of practice based upon the findings in this thesis provide an opportunity to open up the frontiers of digital learning.

Through the development of the *why dimension* this thesis has also established some conceptual foundations that enable, and would benefit from, further research that is both theoretical and applied. In particular, having identified both intelligent tutoring and automated question generation as already informing the theoretical aspects of the *why dimension* then these fields of practice should be further explored for opportunities that directly connect with the findings of this thesis. Such an

endeavour would also benefit from developments in the instructional design and learning design discourses.

From a theoretical perspective further work is needed that focuses upon the distinction between *sense-making* and *meaning-making*, the latter being an important construct in the literature associated with constructivism and "meaning-centered education" (Kovbasyuk & Blessinger, 2013; Jones & Brader-Araje, 2002; Hein, 1999; Jonassen et al., 1995). Such work could inform the ongoing expression of constructivist learning theory as it is applied in the context of digital learning. It would also need to embrace highly technical work that takes account of the growing number of *semantic technologies* (such as tools that develop and render formal ontologies and make use of the Resource Description Framework), which are often associated with the emergence of "Web 3.0" (Hendler, 2009). There are a number of reasons for this but most significant is that the *why dimension* is concerned with *explanatory*, rather than *informational*, content. As such, it is related to content that typically requires reasoning skills and *sense-making* in order to achieve understanding and facilitate learning. In contrast, semantic technologies are focused on parsing semantics and the construction of meaning. In framing this distinction, however, it is important to note that the distinction does not preclude intersection of such technologies – after all, human beings make sense from things that have meaning and vice versa. Furthermore, at a mundane level it could be argued that mainstream tools such as the Google search engine already function as both semantic and sense-making technologies depending upon context and the user. What is being given emphasis here is the scope at the frontier of development.

While the semantic ambiguity associated with *why* presents challenges for semantic technologies (that depend upon formal and precisely defined semantics)

this limitation suggests that *sense-making technologies* provide a counterpoint to *semantic technologies* and this construct has been introduced to specifically describe technologies that might directly support the *why dimension.* It will be through innovation that the efficacy of this argument will achieve validation.

From an applied perspective, empirical studies that can measure the application of the *why dimension* in digital learning could directly inform the scope and design of innovation in the development of *sense-making technologies*. With recent developments in the field of learning analytics, collection of such empirical data will be essential in driving forward a research agenda that draws from the *why dimension*.

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# Appendices

## Appendix A
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| Contributor | Statement of contribution* |
|---|---|
| Jon Mason | As principal author conceived and drafted original manuscript content and structure. |
| Signature |  |
| Date | 17–10–2013 |
| Co-author's name* Prof Hitendra Pillay | Conceptual and theoretical clarification to strengthen the paper. |

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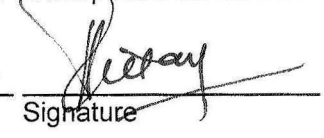 — Signature
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